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This document provides the data and information developed in support of the proposed revision to the rail carrier noise emission regulation. The revision proposed to include standards that limit noise emissions from the operations of equipment and facilities of interstate rail carriers. The document presents information and data to support imposition of a property-line type regulatory standard, and standards for specific pieces of railroad equipment or operation of equipment. The Background Document discusses an industry profile, an identification and classification of railroad equipment and facilities, baseline noise emissions, noise control technology, health and welfare impacts, and cost and economic impacts.

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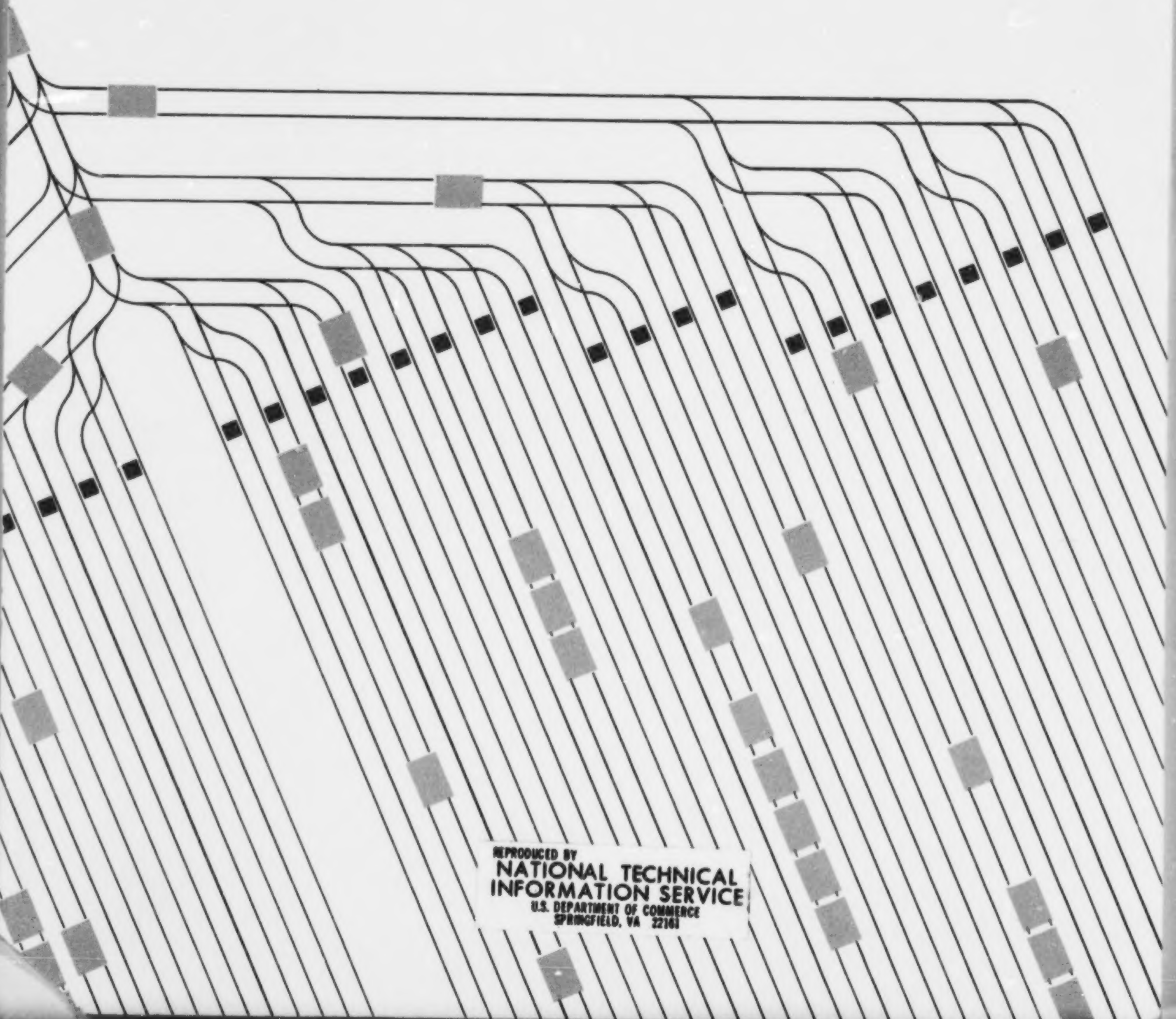

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BACKGROUND DOCUMENT
FOR PROPOSED REVISION TO
RAIL CARRIER NOISE EMISSION REGULATION

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SECTION 1

INTRODUCTION

In accordance with Section 17 of the Noise Control Act of 1972, the U.S. Environmental Protection Agency, on January 14, 1976, promulgated noise emission standards for railroad locomotives and rail cars which are used in interstate commerce. That regulation was challenged in a suit brought against the Agency by the Association of American Railroads (AAR) on the basis that it included only locomotives and rail cars and therefore did not preempt state and local regulation of all rail carriers' equipment and facilities. The U.S. Circuit Court of Appeals for the District of Columbia has ruled that the Agency must broaden the scope of the existing railroad regulation. The text of the Court decision appears in Appendix O.

The January 14,1976 regulation sets maximum noise emissions for locomotives in the stationary and moving modes (73 dBA at idle and 96 dBA measured at 30 meters under maximum load), with a further reduction by January 1980 to a maximum of 90 dBA. The improvement in locomotive emissions is to be achieved through the application of mufflers to the diesel engine exhaust system. Rail car noise, which includes the wheel/rail interaction, is limited to 88 dBA for trains moving at a speed up to 72 km/hr (45 mph) and 93 dBA for trains moving at a speed greater than 72 km/hr with the levels measured at 30 meters. The standards established in the original railroad noise regulation were not affected by the decision of the U.S. Appeals Court for the District of Columbia in Association of American Railroads vs. Costle, and they are not changed by this revision to the Railroad Noise Regulation.

Information and data supporting the January 14, 1976 regulation appears in the Background Document for Railroad Noise Emission Standards, EPA-550/9-76-005, dated December 1975. This report is available by document number PB-251713, from the National Technical Information Services (NTIS), U. S. Department of Commerce, 425 13th Street, N.W., Washington, D. C. 20004.

The Agency now proposes to expand the 14 January, 1976 regulations to include standards which limit noise emissions resulting from the operations of equipment and facilities of interstate rail carriers.

These standards reflect the degree of noise reduction that is achievable through the application of "best available technology, taking into account the cost of compliance".

The revised Background Document specifically presents information and data to support imposition of a property line-type regulatory standard, and standards for specific pieces of railroad equipment or operation of equipment.

SECTION 2

INDUSTRY PROFILE

INTRODUCTION

This section examines the economic role and posture of the railroad industry, including the physical, economic, financial and institutional attributes of the U.S. railroad system and its operations. Since the potential noise regulations are associated largely with the operation of railroad yards, this profile includes a brief description of the importance of yards in overall railroad operations.

Also described in this section are the size of the industry, recent patterns in the behavior of industry revenues and costs and the financial conditions under which today's U.S. railroad industry is operating. The description will establish a framework in which the problem of noise emission and its control can be examined.

PHYSICAL PROFILE

Background Information

As of 1977, 260 line-haul railroads and 80 switching and terminal companies constituted the U.S. railroad industry.[1] These railroads together operated more than 4,100 railroad yards.[2] For statistical reporting purposes, these railroads have been divided into two groups by the Interstate Commerce Commission - Class I and Class II organizations. In 1977 there were 52 line-haul railroads in Class I (excluding Amtrak and Auto-Train), which together represent about 99 percent of railroad industry traffic, operate 96 percent of rail mileage and account for 91 percent of workers employed by all railroad companies.[3] Since the Class I railroads represent such a significant portion of the total industry, and because data on the Class I railroads is more readily available than data for Class II railroads, much of the remaining discussion will be confined to Class I railroads. No significant information will be lost because of this simplification.

As of 1976 the inventory of these railroads included the following:

TABLE 2-1

LOCOMOTIVE AND FREIGHT CAR INVENTORY

CLASS I LINE-HAUL RAILROADS

(1976)

	Units
Locomotives	
Yard Service	6,330
Road Freight Service	20,699
Road Passenger Service	416
Freight Cars on Line	1,496,164

Individual railroad detail, by region, for this summary table is shown in Appendix K Table K-1.

In addition to the line-haul railroads, 21 companies were designated Class I switching and terminal companies in 1977 (see Appendix K Table K-2). As indicated by the title, these companies are not involved in line-haul traffic but instead confine their operation primarily to providing services associated with car switching, terminal trackage or similar facilities and their operations. Many of these terminal companies operate within the proximity of large industrial plants, for example, several of these railroads operate within steel mills and are wholly owned subsidiaries of the steel producers.

Yards in the U.S. Railroad System

Line-haul railroads and switching and terminal companies own and operate a sizeable number of yards. These facilities perform several functions for the railroad industry and are strategically located throughout the network. A summary of the yard inventory,[2] shown in Table 2-2, portrays the yard distribution by function and by yard type. A classification yard receives, disassembles, reassembles, and dispatches line-haul traffic. Generally industrial yards provide the freight interface between the railroads and other U.S. industries. Flat yards employ locomotive power for all car movements within a yard complex, while hump yards are designed to utilize a gravity-feed system to classify trains of cars into departure configurations. As shown in these data, hump yards represent only three percent of the current yard inventory. However, they are massive, expensive complexes that perform a variety of support services for the industry. A detailed description of railroad yard operations is presented in Section 3.

TABLE 2-2

SUMMARY OF THE U.S. RAILROAD YARDS IN 1976 & 1977
BY ICC CLASS I & II RAILROAD COMPANIES

YARD FUNCTION BY TYPE OF YARD

	CLASSIFICATION		INDUSTRIAL			
CLASS	HUMP	FLAT	IND.	SM. IND.	TOTAL	PERCENTAGE
I	117	1,047	1,183	1,349	3,696	88.7
II	7	66	198	202	473	11.3
TOTAL	124	1,113	1,381	1,551	4,169	100.0

Appendix E presents a tabulation of railroad companies for each category, the number of yards that it operates is shown. In addition, this appendix incorporates the ownership distribution of railroad yards. Appendix K, Table K-3, contains a tabulation of railroad companies which operate yards by ICC CLass designations (Class I and II) and region (for Class I railroads). For each company, the number of yards by type are tabulated and then summed. The actual railroad company names can be ascertained in Appendix F. Table K-4 in Appendix K lists the roads which changed ICC class designations between the years 1976/77 and 1978.

TABLE 2-3

NATIONAL INCOME ORIGINATING IN THE TRANSPORTATION AND RAIL SECTORS ($ IN BILLIONS)

YEAR	GROSS NATIONAL INCOME[1]	TRANSPORTATION	TRANSPORTATION AS % OF INCOME	RAIL	RAIL AS OF % OF TRANSPORTATION
1950	$242.8	$13.4	5.5%	7.1	53.0%
1960	418.0	18.1	4.3	6.7	37.0
1970	804.4	30.3	3.8	7.6	25.1
1975	1246.7	44.5	3.6	9.9	22.2
1976	1399.3	50.6	3.6	11.1	21.9

[1] SOURCE: Statistical Abstract of the U. S., 1977, p. 434

ECONOMIC PROFILE

Economic Role

The railroad industry occupies an important place in the national economy. However, growth in its volume has lagged behind that of trucking, its strongest competitor. As Table 2-3 displays, 5.5 percent of the national income originated in the transportation sector in 1950, and railroads represented 53 percent of the total transportation revenues. By 1976, transportation represented 3.6 percent of national income, but the railroads represent only 22 percent of transportation. Table 2-4 chronicles the railroads' declining share of total U.S. freight transportation. As the table indicates, railroads' share has declined from 57 percent in 1950 to 36 percent in 1975, with trucks and pipelines gaining at the railroads' expense.

The data displayed in Table 2-5 reflect the aggregate of a number of commodities which comprise intercity freight traffic. For example, during 1975, U.S. railroads transported 123 million tons (MT) of agricultural products, 918 MT of materials resulting from mining, 121 MT of food and drug commodities, and 110 MT of lumber and lumber products.[4] Although these four commodities represent approximately 75 percent of the total tonnage handled by the railroad system, they are also a major commodity transported by water or motor carriers. Fifty-two percent of the tonnage transported by water carrier consists of agricultural and mining products. Motor carriers and railroads derive approximately equal fractions of their annual revenue from lumber and building products, and food and drug commodities. Rail, water or motor carriers also transport substantial quantities of textiles, furniture, paper products, chemicals, stone and glass, iron and steel, and motor vehicles.

Since all of the above commodities are presently carried by more than one means of freight service, the railroads' share of these markets is particularly sensitive to cost and service comparisons. Although the railroad industry may never be totally excluded from the transport of these commodities, rail cost increases or reductions in rail service could result

TABLE 2-4

VOLUME AND PERCENTAGE OF DOMESTIC INTERCITY FREIGHT TRAFFIC BY TYPE OF TRANSPORT

YEAR	TOTAL VOLUME (Billion Ton-Miles)	RAILROAD VOLUME (Billion Ton-Miles)	RAILS'% OF TOTAL	MOTOR VEHICLES' %OF TOTAL	INLAND WATERWAYS' %OF TOTAL	OIL PIPELINES' %OF TOTAL	AIRWAYS' %OF TOTAL
1950	1,094	628	57.44	15.80	14.93	11.81	.029
1960	1,330	595	44.73	21.46	16.56	17.19	.058
1970	1,936	771	39.83	21.28	16.46	22.26	.17
1973	2,232	858	38.51	22.66	16.08	22.75	.175
1974	2,212	852	38.52	22.38	16.05	22.87	.18
1975	2,080	757	36.39	23.46	16.49	23.46	.192

SOURCE: Statistical Abstract of the U. S., 1978 p. 627.

in the loss of some of this business to the other available and qualified carriers. Energy considerations, which generally favor water and rail carriers over truck carriers,[5] may partially compensate for adverse cost or service conditions for rail carriers. It should be noted, however, that water and motor carriers are viable alternatives to the railroad industry for the movement of a substantial fraction of intercity freight traffic and many of the commodities which comprise that traffic.

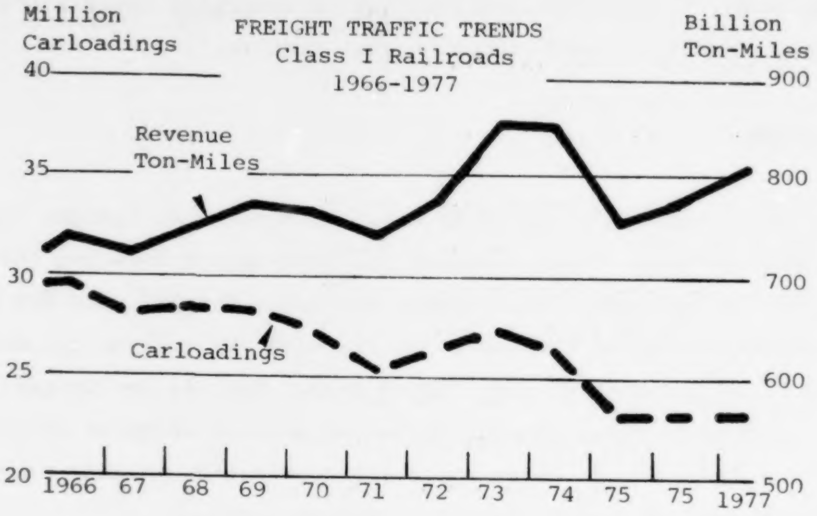
Railroad Volume

Railroad revenues are earned from two main sources: freight traffic and passenger service. Total revenues declined during 1974 and 1975 but are again on the increase. Preliminary estimates for 1977 are 800 billion freight revenue ton-miles for the industry, with 794 billion ton-miles carried by Class I companies (See Figure 2-1). Coal is the largest single commodity carried by rail, accounting for 20 percent of total carloadings in 1977. (See Table 2-5.) Other important commodities include chemicals, motor vehicles and equipment, metallic ores and grain.

Passenger service has diminished from 24 percent of total railroad revenues to about 3 percent in recent years. In 1977, Amtrak-operated trains accounted for 4.2 billion passenger-miles, with another 218 million passsenger-miles attributable to Auto-Train.[6] While Class I railroads, other than Amtrak and Auto-Train, accounted for only 1.1 billion intercity passenger-miles, they represent nearly all of commuter traffic, or 4.5 billion of the 4.6 billion commuter passenger-miles.

Railroad Employment and Wages

Railroad employment trends generally seem to follow those of total railroad output, declining over time both absolutely and as a share of U.S. employment. Tables 2-6 and 2-7 portray these declines. As Table 2-6 demonstrates, Class I railroads accounted for 2.7 percent of non-agricultural U.S. employment in 1950, and by 1976 the share had fallen to 0.6


FREIGHT TRAFFIC TRENDS
Class I Railroads
1966-1977

SOURCE: "Review of 1977", Railway Age, Jan. 30, 1978

FIGURE 2-1

TABLE 2-5

REVENUE CARLOADING BY COMMODITY GROUPS

(Carloadings shown in thousands)

	1977	Percent of Total
Coal	4,713	20.2
Chemical and allied products	1,411	6.1
Motor vehicles and equipment	1,335	5.7
Metallic ores	1,312	5.6
Grain	1,250	5.4
Primary forest products	1,112	4.8
Pulp, paper and allied products	1,103	4.7
Food and kindred products	1,028	4.4
All others	10,034	43.1
TOTAL CARS LOADED	23,298	100.0

SOURCE: "Review of 1977", Railway Age, January 30, 1978.

TABLE 2-6
EMPLOYMENT ON CLASS I RAILROADS RELATIVE TO THE NATIONAL ECONOMY

Year	Number of All Employees In Non-Agricultural Establishments (1000)	Railroad Class I Employment (1000)	Class I as % of National Total
1950	45,222	1220	2.7%
1960	54,234	780	1.4%
1965	60,815	640	1.1%
1970	70,920	559	0.8%
1975	77,051	491	0.6%
1976	79,443	490	0.6%

Source: Statistical Abstract of the U.S. 1977, Table No. 657.

TABLE 2-7

EMPLOYEES AND THEIR COMPENSATION - 1967-1977

Year	Average No. of Employees	Total Payroll (Thousands)	Average Annual Earnings Per Employee	Average Straight-Time	
				Hourly Rate	Hourly Earnings
1967	610,191	$4,933,663	$ 8,085	$3.30	$3.56
1968	590,536	5,110,636	8,654	3.47	3.74
1969	578.227	5,362,754	9,274	3.70	4.00
1970	566,282	5,711,280*	10,086*	4.05*	4.35*
1971	544,333	5,999,968*	11,023*	4.52*	4.84*
1972	526,061	6,424,920	12,213	4.94	5.32
1973	520,153	7,088,383	13,627	5.43	5.83
1974	525,177	7,475,834	14,235	5.72	6.16
1975	487,789	7,474,800*	15,324*	6.30*	6.77*
1976	482,882**	8,278,400	17,141	6.96	7.49
1977 Est.	485,200	8,743,600	18,121	7.43	7.99

* Adjusted to include retroactive increases

** The decline in employment in 1976 is attributable in part to the transfer to Amtrak of certain rail properties and personnel in the Northeast Corridor.

SOURCE: "Review of 1977", Railway Age, January 30, 1978.

percent. Annual data over the past decade are shown in Table 2-7, which includes average employment and compensation. While employment had been decreasing, the total annual payroll had risen to a high of $8.7 billion in 1977.

Moreover, increases in wage rates for railroad employees over the decade have been greater than increases in the manufacturing sector, as shown in Table 2-8. In 1970, the average hourly earnings per worker in manufacturing (private) were $3.22.[7] The average rail empoyee's earnings per hour were $4.35[8] or 135 percent of the average compensation in manufacturing. By 1976, the wages were $4.87 and $7.09 for the manufacturing and rail sectors, respectively.

Railroad Profitability

Railroad profitability has declined significantly over the past 12 years. This is portrayed in Figure 2-2, which shows net railroad operating income in both current dollars and in constant 1966 dollars for the years 1966 through 1977. Net railway operating income (NROI) is operating revenues less operating expenses, taxes and rents for equipment in joint facilities. Note that non-operating income and fixed costs are not a part of the NROI calculation.

Working Capital

As demonstrated in Table 2-9, railroads have experienced a decline in net working capital. The table shows the derivation of net working capital and compares it with long-term debt maturing within one year. As indicated, working capital has declined significantly, with deficits in three of the past four years. Maturing long-term debt has increased steadily over the period, requiring ever increasing borrowing on the part of the railroad.

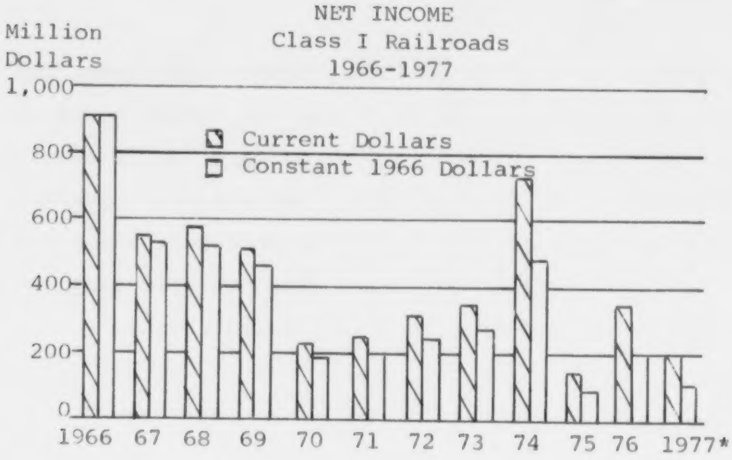
Net Income and Rate of Return

The financial difficulties experienced recently by the railroad industry are shown most vividly by the data of Table 2-10. Net

TABLE 2-8
COMPARISON OF WAGE RATE INDEXES

(Base Year: 1968)

Industry	1970	1971	1972	1973	1974	1975	1976
Manufacturing	121.7	129.8	137.0	147.0	161.7	179.8	193.2
Class I RR	125.6	139.4	153.4	173.9	189.1	207.1	230.2



*12 months ended Sept. 30

FIGURE 2-2

TABLE 2-9

NET WORKING CAPITAL AND MATURING DEBT

(Dec. 31)	Total (millions)	Current assets excluding material & supplies (millions)	Current Liabilities (millions)	Working capital (millions)	Long-term debt maturing within one year (millions)
1966	$3,257	$2,750	$2,279	$477	$529
1967	3,094	2,595	2,319	276	525
1968	3,180	2,054	2,501	153	615
1969	3,379	1,876	2,820	56	744
1970	3,583	3,032	2,923	109	601
1971	3,586	3.031	3,017	14	631
1972	3,612	3,070	3,049	21	623
1973	4,056	3,469	3,275	194	623
1974	4,553	3,651	3,721	(70)	613
1975	4,641	3,622	3,838	(217)	735
1976	5,293	4,212	4,211	1	739
9-30-77	5,633	4,424	4,425	(1)	751

Parentheses indicate a deficit.

Source: "Review of '77", Railway Age, Jan. 30, 1978, p. 65.

TABLE 2-10

RATE OF RETURN AND NET INCOME - 1966-1977

Year	Net railway operating income[a] (millions)	Rate of return on investment after depreciation[b]	Net income after fixed charges[c] (millions)	Net income in constant 1966 dollars[c] (millions)
1966	$1,046	3.90%	$904	$904
1967	676	2.46	554	538
1968	678	2.44	569	529
1969	655	2.36	514	455
1970	486	1.73	227	191
1971	595	2.12	247	197
1972	654	2.34	319	245
1973	650	2.33	359	261
1974	768	2.70	730	483
1975	351	1.20	145	88
1976	452	1.60	355	204
12 mos. to 9/30/77	343	1.27	202	111

[a] Ordinary income before extraordinary and prior-period charges and credits.

[b] After provision for deferred taxes beginning in 1971.

[c] After provision for deferred taxes beginning in 1971 and including equity in undistributed earnings of affiliated companies beginning in 1974.

Source: "Review of '77", Railway Age, Jan. 30, 1978, p.59.

railway operating income (column 1) shows a dramatic decline from a 1966 high of over 1 billion dollars to less than 400 million in two of the past three years. Discounting the 1966 high, the performance of the past three years is clearly lower than that of prior years. Columns 3 and 4 reflect essentially the same income data after the deduction of fixed charges. Here the picture is the same, with distinct declines over the period, and 1975 and 1977 displaying the poorest performance of the decade. Rate of return on investment, shown in column 2, further describes the generally poor condition of the U.S. railroads. In no year since 1966 has the rate of return on investment been as high as 4 percent. In four of the past 12 years, including the last three, the rate of return has been lower than 2 percent.

Much of this general decline is accounted for by the Eastern railroads, as shown in Table 2-11. The railroads in both the Southern and Western districts depict essentially uniform returns on investment over the 1966-76 period.

Summary and Conclusions

The railroad industry has experienced serious problems of national dimensions. A number of factors operate jointly which have resulted in poor operating conditions for many U.S. railroads. These problems have been most acute in the Northeast where Penn Central and other Class I railroads have been reorganized as Conrail. Several other Class I railroads have considered or undertaken steps leading to mergers in recent years.

Changes in the American economy have slowed the growth of the total intercity rail freight demand. Another significant influence on the railroads' viability is the competitive position of railroads in relation to truckers because of the interstate highway system. Shippers have chosen truck transportation in lieu of railroads because of improved service delivery on some specific commodities. The railroads have not adapted quickly to these changes. In the absence of traffic growth sufficient to offset salary gains by labor, railroad employment has dropped. The rate of return on investment of Class I railroads in transportation property has only been 2.8 percent during the past ten years, discouraging new capital investment.

TABLE 2-11

RATE OF RETURN ON INVESTMENT AFTER DEPRECIATION BY REGIONS

Year	United States	Eastern District	Southern District	Western District
1929	5.30%	6.03%	4.27%	4.85%
1939	2.56	3.14	2.77	1.85
1944	4.70	4.37	5.45	4.62
1947	3.44	3.02	3.52	3.84
1951	3.76	3.47	4.74	3.76
1955	4.22	4.10	5.45	3.86
1962	2.74	1.80	4.17	3.15
1963	3.12	2.28	4.04	3.60
1964	3.16	2.56	4.01	3.43
1965	3.69	3.32	4.16	3.87
1966	3.90	3.55	4.45	4.03
1967	2.46	1.58	3.86	2.75
1968	2.44	1.27	3.79	3.01
1969	2.36	1.10	4.17	2.81
1970	1.73	(—)	4.50	3.02
1971*	2.12	(—)	4.36	3.51
1972*	2.34	0.11	4.61	3.34
1973*	2.33	0.11	4.01	3.34
1974*	2.70	0.46	4.73	3.66
1975*	1.20	(—)	3.98	2.65
1976*	1.60	(—)	4.62	3.57

Parentheses indicate deficit.

* Reflects inclusion of deferred taxes.

Analysis of income and rate of return point to a weak financial position for railroads. Declining profits have caused a cutback in capital investment to maintain and/or add to real assets. Low earnings from slow growth in revenues eventually necessitates further borrowing to cover total operating and investment costs. The low rates of return to equity discourage potential lenders, and the costs of accessible investment funds rise accordingly. This cycle of cause and effect appears to characterize the railroad industry.

For a more comprehensive discussion and analysis of the railroad industry's importance to the Nation, current situation and causes of it's problems, intermodal competition, restructuring of the industry and a look at it's future, the reader is referred to a recent Department of Transportation document.[9]

FOOTNOTES AND REFERENCES

Footnotes

1. The Official Railroad Equipment Register, Vol. 93, No. 2 National Railway Publication Company, New York, N.Y., October 1977.

2. Railroad Classification Yard Technology - A Survey and Assessment, Stanford Research Institute, Menlo Park, California, January, 1977.

3. Yearbook of Railroad Facts, 1978 Edition, Association of American Railroads.

4. Intercity Domestic Transportation System for Passengers and Freight, U.S. Government Printing Office, 1977.

5. Final System Plan, Supplemental Report, U.S. Railway Association, September, 1975.

6. Class I List of Principal Railroads in the United States, Association of American Railroads, Washington, D. C., September, 1976.

7. Statistical Abstract of the U.S. 1977, U.S. Department of Commerce, Bureau of the Census, p. 402.

8. Yearbook of Railroad Facts 1977, p. 57.

9. A Prospectus for Change in the Freight Railroad Industry A Preliminary Report by the Secretary of Transportation, U.S. Department of Transportation, October 1978.

Other References

Eighty-Ninth Annual Report on Transport Statistics in the United States for the Year Ending December 31, 1975 - Part I Railroads, Bureau of Accounts, Interstate Commerce Commission, Washington, D.C.

Final Standards, Classificaiton, and Designation of Lines of Class I Railroads in the United States, Vol. II, U.S. Department of Transportation, June 30, 1977.

Class I List of Principal Railroads in the United States, Association of American Railroads, Washington, D.C., January, 1978.

Yearbook of Railroad Facts - 1977 Edition, Association of American Railroads, Washington, D.C.

Operating and Traffic Statistics - Class I Line-Haul Rail roads in the United States, O. S. Series No. 218, Year 1976, Association of American Railroads, Washington, D.C.

FOOTNOTES AND REFERENCES (Continued)

Conrail consolidated the properties of the former Penn Central, Erie Lackawanna, Reading, Central of New Jersey, Lehigh Valley, and Lehigh and Hudson River, and has operating responsibility for the Ann Arbor.

Railroad Quiz, Office of Information and Public Affairs, AAR.

"Review of 1977", Railway Age, Vol. 179, No. 2, January 30, 1978.

One component to note (cf. Table 2-6) is the increase in maintenance-of-way expenses. This indicates not only rising costs but also the increasing amount of track mileage needing maintenance.

Improving Railroad Productivity, Task Force on Railroad Productivity for the National Commission on Productivity and the Council of Economic Advisors, Washington, D.C., November 1973.

Domestic Transportation System for Intercity Passenger and Freight, Commerce, Science, and Transportation Committee Report, 95th Congress, Washington, D.C., 1977.

SECTION 3

IDENTIFICATION AND CLASSIFICATION OF RAILROAD EQUIPMENT AND FACILITIES

RAILROAD EQUIPMENT AND FACILITIES

Railroad property consists of equipment and facilities. Equipment includes locomotives, cars, and special purpose items for maintenance-of-way and marine applications. Facilities consist of track, tunnels, bridges, yards, and a host of general or special purpose buildings.[1] Table 3-1 presents a list of the major items of railroad property.

The property, shown in general terms in Table 3-1, may be expanded by the type or function of each item. For example, there are four types of rail lines described by annual traffic density (i.e, A Main, B Main, A Branch, and B Branch). Table 3-2 indicates that two basic types of locomotives, diesel and electric, perform four functions.[2] Table 3-3 shows that railroad freight cars fall into nine functional categories.[3]

Special purpose equipment for marine applications and maintenance-of-way is listed in Table 3-4[3]. Although this tabulation may not be all inclusive, it reflects the majority of the inventory of this type of railroad property.

The functions of railroad yards are: classification, storage, interchange, trailer/container on flatcar handling, and local switching/industrial interfacing.[4,5] These facilities employ locomotive power for freight equipment movement through the yards (flat yards) or they rely upon gravity and yard grades for car movement through portions of the yard complex (hump yards).

TABLE 3-1

RAILROAD PROPERTY

FACILITIES		
Lines	Stations	Power Generating Facilities
Tunnels	Office Buildings	Communication Facilities
Bridges	Service Facilities	Freight Terminals
Trestles	Repair Facilities	Marine Terminals
Culverts	Manufacturing Facilities	Flat Yards
Elevated Structures	Testing Facilities	Hump Yards
		Power-Transmission Facilities

PRINCIPAL EQUIPMENT
Locomotives
Cars
Special Purpose Equipment (including Marine)

TABLE 3-2

RAILROAD LOCOMOTIVES

Type	Function
Diesel	Road Passenger Road Freight Road Switcher Yard Switcher
Electric	Road Passenger Road Freight Yard Switcher

TABLE 3-3

RAILROAD FREIGHT EQUIPMENT CARS

Box Car
Refrigerator Car
Stock Car
Gondola Car
Hopper Car
Flat Car
Tank Car
Special Car
Caboose

TABLE 3-4

SPECIAL PURPOSE EQUIPMENT

- Ballast Cribbing Machines
- Belt Machines
- Brush Cutters
- Compactors
- Welding Machines
- Snow Plows
- Spike Pullers
- Crosstie Replacers
- Cranes
- Spike Drivers
- Ballast Tampers
- Rail Aligners
- Ballast Cars
- Crosstie Cars
- Weed Sprayers
- Ditching Car
- Rail Saw
- Rail Bender
- Track Layer
- Caboose and Tool Car
- Dump Car
- Ballast Spreader and Trimmer
- Flat Car
- Track Inspection Car
- Hand Car
- Ballast Unloader
- Snow-Removing Car
- Store-Supply Car
- Pile Driver
- Steam Shovel
- Tool and Block Car
- Derrick
- Boarding Outfit Car
- Car Ferries
- Car Floats
- Tugs

Table 3-1 contains other types of facilities which are not covered under lines and yards. These are stations, terminals, and isolated facilities which perform support functions. Stations and terminals include freight, passenger, and marine facilities. Support facilities cover such functions as service and repair, power generating and transmission, and manufacturing and testing.[1]

The purpose of this section is to reorganize the equipment and facilities of the railroad industry into a logical classification system. This system will permit the identification of noise sources within the railroad industry and will allow for the effective and efficient assignment of noise abatement techniques to the proper source or sources.

CLASSIFICATION OF RAILROAD PROPERTY

Table 3-5 summarizes the items presented in the preceding subsection and suggests that all railroad property be grouped into four categories: lines, stations/terminals, yards, and isolated support facilities. Each category is divided into several types of property. The principal equipment which operates in, or on, each of the four categories of property are also listed. Although other types of railroad equipment may be associated with each of the properties shown, this tabulation includes only principal items of railroad property.

CLASSIFICATION SYSTEM FOR RAILROAD YARDS

The preceding discussion indicates that there are two principal types of yards in the railroad system, (i.e. hump and flat). There are, however, several subtypes of yards within each principal type. These subtypes are defined by function, location, land use, activity level, and the population of the yard's locality.

TABLE 3-5

CLASSIFICATION OF RAILROAD PROPERTIES

Category of Railroad Property	Type of Railroad Property	Associated Principal Equipment
Lines	"A" Main $\geq$ 20M* "B" Main 5-20M* "A" Branch 1-5M* "B" Branch < 1M*	Locomotives Rail Cars Special Purpose Equipment
Stations/Terminals	Freight Passenger Marine	Locomotives Rail Cars Special Purpose Equipment Ferries Floats Tugs
Yards	Hump Flat	Locomotives Rail Cars Special Purpose Equipment
Isolated Support Facilities	Service Repair Manufacturing Testing Power Generating Power Transmission Communication	

* M = millions of gross ton-miles per mile per year.

The two primary functions of railroad yards are the assembly, disassembly, and reassembly of line-haul trains (classification yard); and the collection and distribution of cars to provide freight service to and from other industries (industrial yard).[4,5]

The primary land uses adjacent to the locations of railroad yards are:

- Industrial
- Commercial
- Residential
- Agricultural
- Undeveloped

The activity levels selected for both principal types of yards are presented in Table 3-6.[4] It should be noted that these activity levels only apply to yards performing the classification function. They do not apply to those yards whose only function is freight service to and from industry (i.e., industrial yards).

The population of a yard's locality is described by six population categories. These are:[4]

- 0-5000 people
- 5,000-50,000 people
- 50,000-100,000 people
- 100,000-250,000 people
- 250,000-500,000 people
- >500,000 people

The system for the classification of railroad yards is summarized in Table 3-7.

TABLE 3-6

ACTIVITY LEVELS FOR RAILROAD YARDS

Yard Type	Yard Activity	Number of Cars Classified per Day
Hump	Low	<1000
	Medium	1000-2000
	High	>2000
Flat	Low	<500
	Medium	500-1000
	High	>1000

TABLE 3-7

CLASSIFICATION SYSTEM FOR RAILROAD YARDS

YARD CHARACTERISTIC		Legend
Yard Type:	Hump	(H)
	Flat	(F)
Yard Function:	Classification	(C)
	Industrial	(I)
	Classification/Industrial	(C/I)
Adjacent Land Use:	Industrial	(I)
	Commercial	(C)
	Residential	(R)
	Agricultural	(A)
	Undeveloped	(U)
Yard Locality Population:	0-5000	(1)
	5000-50,000	(2)
	50,000-100,000	(3)
	100,000-250,000	(4)
	250,000-500,000	(5)
	>500,000	(6)

DESCRIPTION OF TYPICAL RAILROAD YARDS

Hump Yards

Hump yards perform both the classification and industrial service functions for U.S. railroads. This type of yard generally consists of a subyard to receive incoming line-haul traffic, a subyard where these trains are broken up and reassembled into outbound configurations, and a subyard for outbound traffic. These three subyards are defined as receiving, classification, and departure "yards" respectively, as shown below in Figure 3-1.[5]

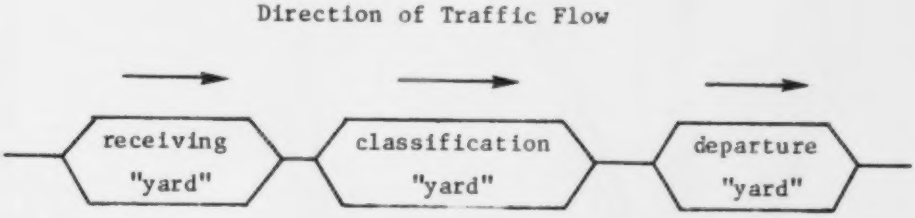


FIGURE 3-1. SCHEMATIC OF HUMP CLASSIFICATION YARD

The unique characteristic of hump yards is that they employ a gravity-feed system between the receiving subyard and the classification subyard. This system consists of a hump crest and a series of retarders for car spacing and speed control. This feature of all hump yards is shown in plan and elevation view on Figure 3-2.[5] Not shown are the "inert" retarders which are located at the departure end of each classification track. It should be noted that some hump classification yards also contain approach retarders (upstream of the hump crest), tangent point retarders (downstream of the group retarders, at the origin of each classification track), and intermediate retarders (between the master and group retarders). A description of these retarding devices is contained in Section 5 of this document.

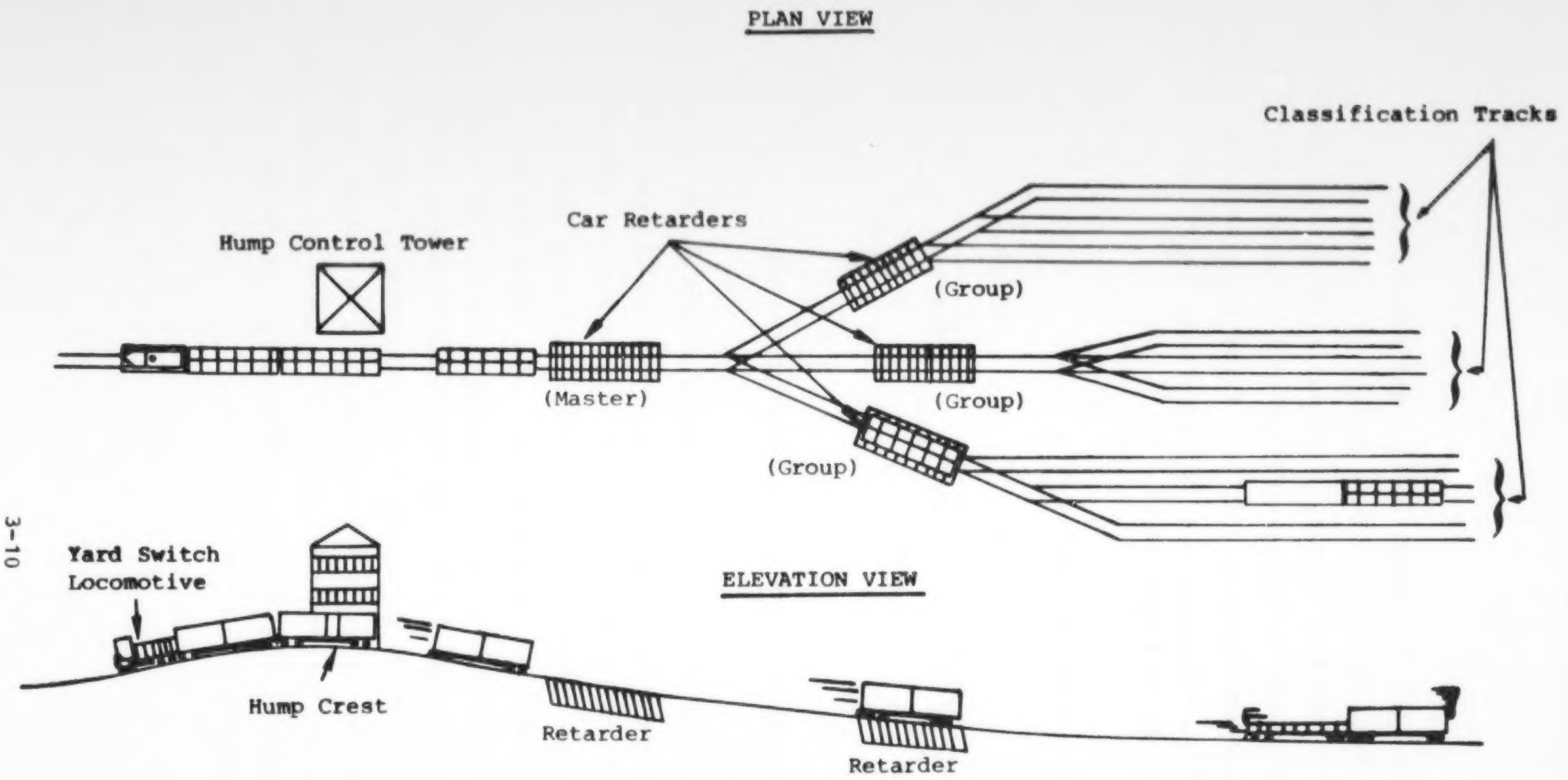


FIGURE 3-2. HUMP YARD CREST AND RETARDER SYSTEM

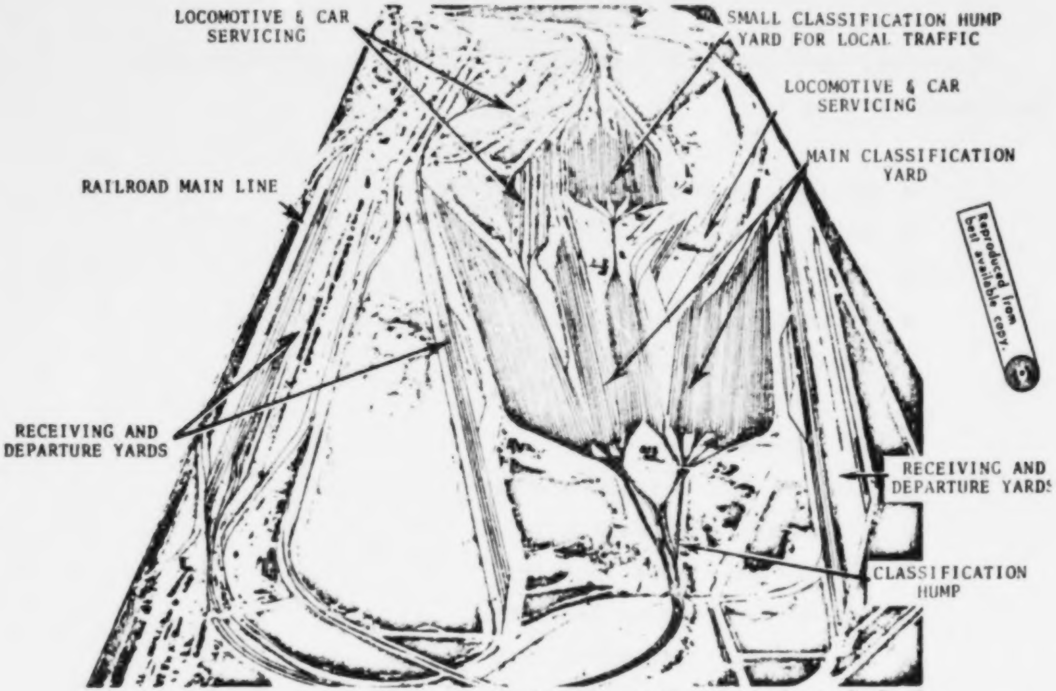
A typical hump yard also contains a variety of buildings and facilities, such as:

- Office/Administration Buildings
- Stock Pens
- Trailer Ramp
- Powerhouse
- Compressor Building
- Hydraulic Pump House
- Fuel Pump House
- Car One Spot Service and Repair Facility
- Caboose Service Facility
- Locomotive Washer Facility
- Locomotive Service Facility
- Maintenance-of-Way Facility

All types of locomotives can generally be found operating or undergoing service, maintenance, and perhaps, repair in hump yards. Further, all types of freight cars pass through hump yards and many of the way maintenance machines may be employed in, or housed on, hump yard complexes.

The three subyards of the yard complex may be arranged in various configurations, as shown in Figure 3-3.

The physical characteristics of hump yards vary considerably depending upon yard configuration and yard capacity. However, as shown in Figure 3-4, yard activity or capacity, measured in terms of car classifications per day, is a function of the number of tracks in the classification "subyard". Further, the number of group retarders may be approximated from classification track data as shown in Figure 3-5. Hump yards are usually several miles long and a few thousand feet wide.


LOCOMOTIVE & CAR SERVICING
SMALL CLASSIFICATION HUMP YARD FOR LOCAL TRAFFIC
LOCOMOTIVE & CAR SERVICING
MAIN CLASSIFICATION YARD
RAILROAD MAIN LINE
RECEIVING AND DEPARTURE YARDS
RECEIVING AND DEPARTURE YARDS
CLASSIFICATION HUMP

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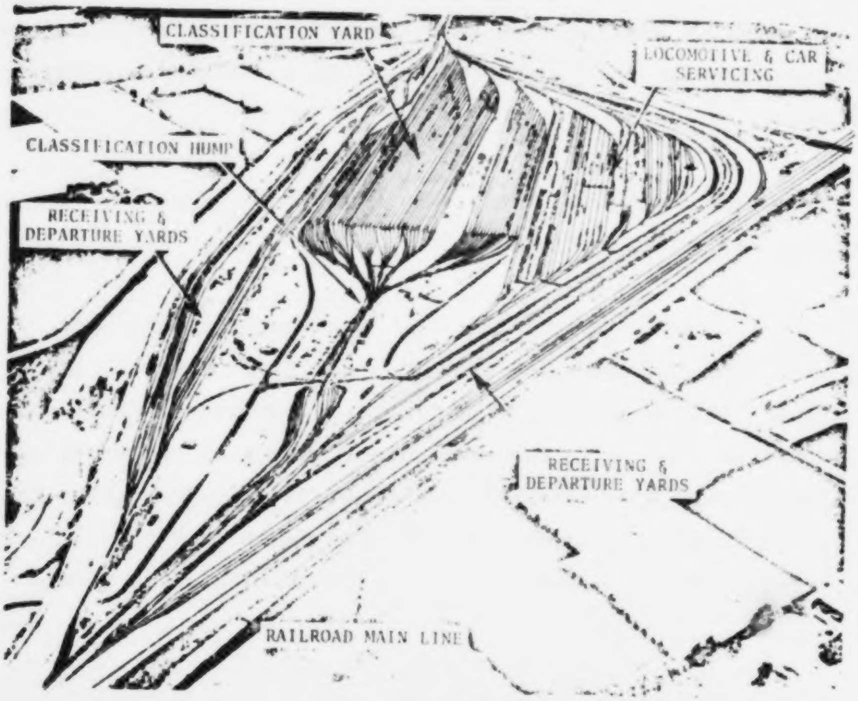

CLASSIFICATION YARD
LOCOMOTIVE & CAR SERVICING
CLASSIFICATION HUMP
RECEIVING & DEPARTURE YARDS
RECEIVING & DEPARTURE YARDS
RAILROAD MAIN LINE

Courtesy of Westinghouse Air Brake Co.

FIGURE 3-3. TYPICAL MODERN CLASSIFICATION HUMP YARD LAYOUTS

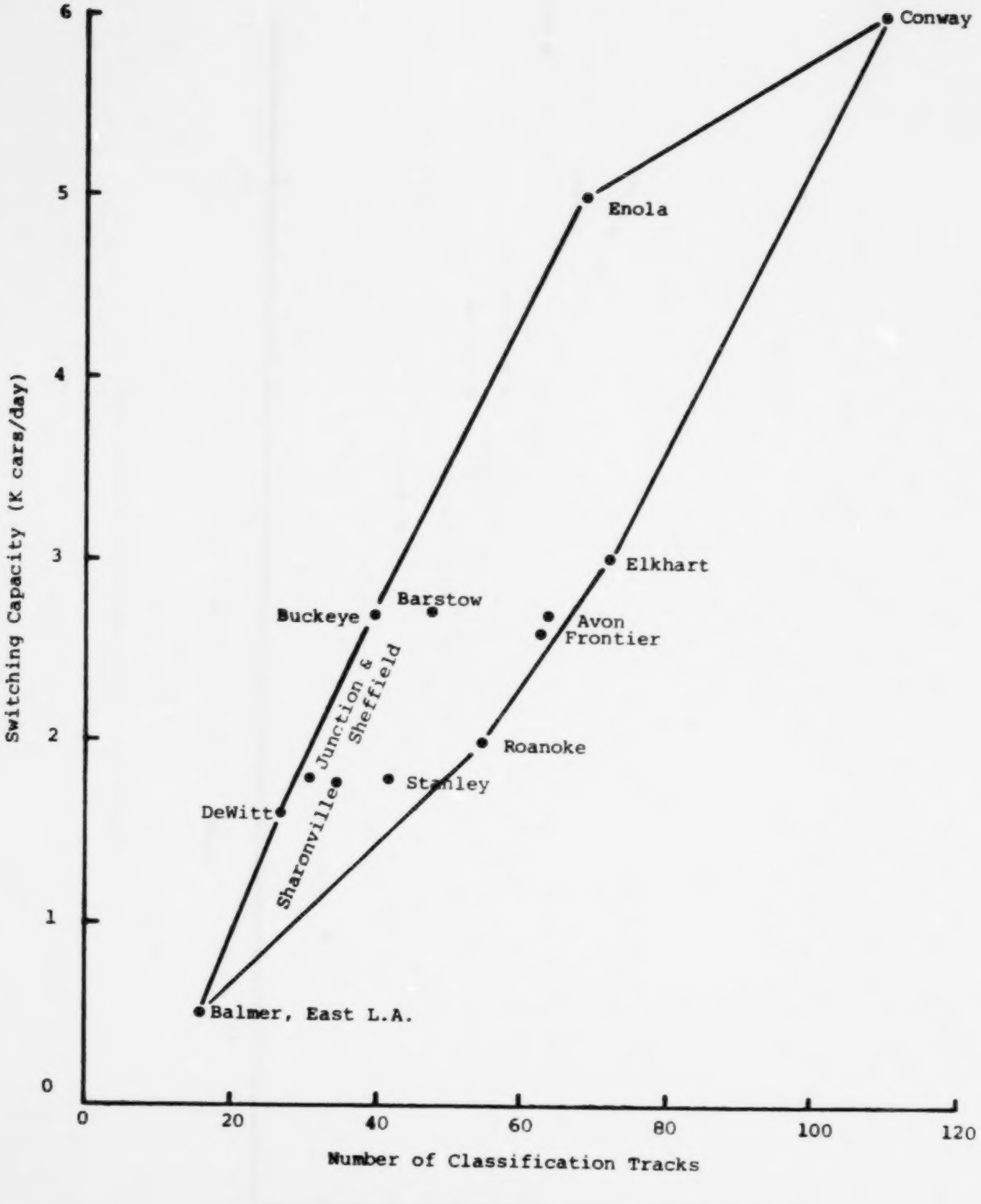


FIGURE 3-4. HUMP YARD CAPACITY

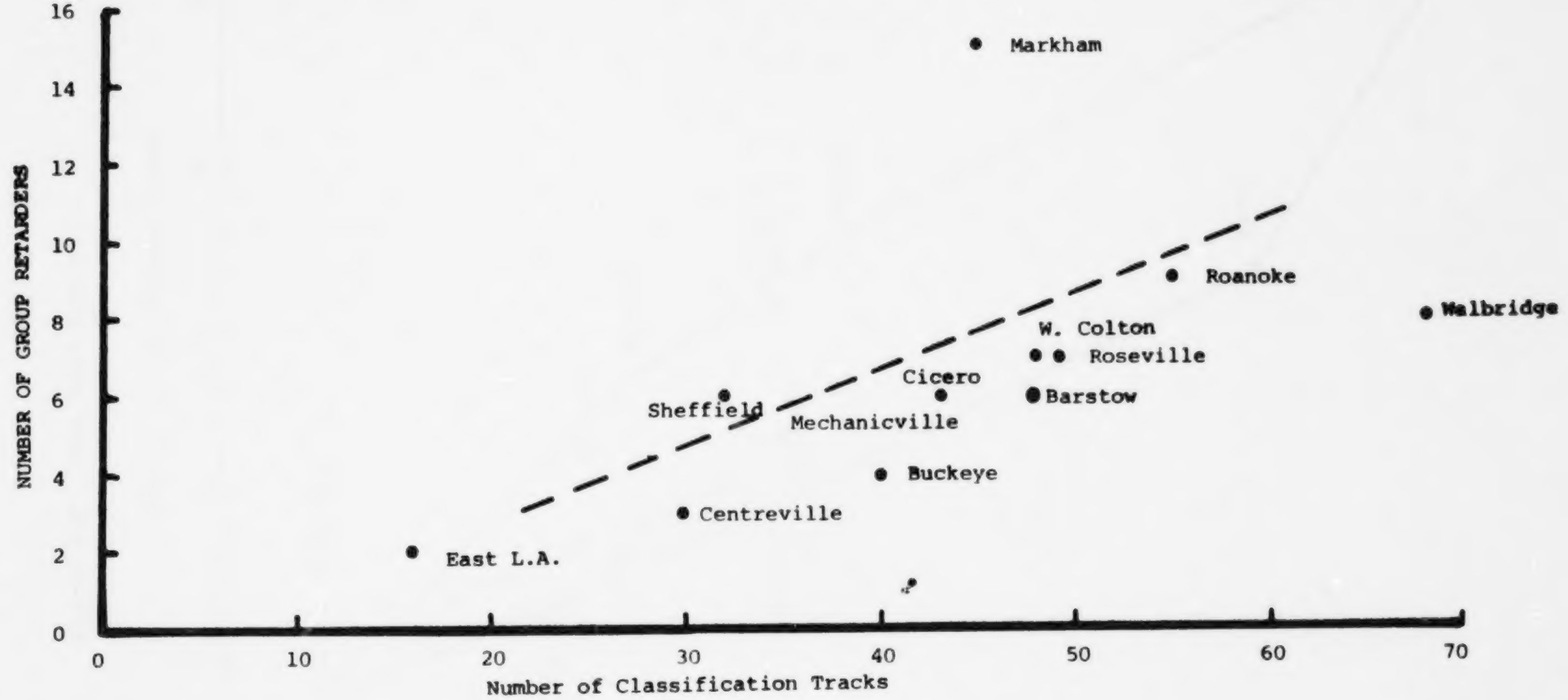


FIGURE 3-5. GROUP RETARDERS IN HUMP YARDS

Each of the three "subyards" have a standing capacity of hundreds of cars resulting in a total standing capacity of thousands of freight equipment cars. Hump yards process dozens of trains per day and sometimes contain hundreds of miles of track within the complex.

Some of the major characteristics of this type of railroad facility are summarized in Table 3-8. These data are based upon the two preceding figures and extractions from other reports.[4,5] Hump yard operational procedures may be found in Section 2.3 of Railroad Classification Yard Technology.[4]

Flat Yards

Flat yards also perform the classification and industrial service functions for the railroad system. This type of yard does not contain specific "subyards" for receiving, classification, and departure but is generally configured as shown in Figure 3-6.[4]

Yard switch locomotives move cars out of the receiving tracks and use either continuous push or acceleration/braking techniques to distribute them into specific classification tracks. The continuous push or the accelerate/brake action of the switch locomotive accomplishes the same function in a flat yard as the "crest-roll-retard" action in a hump yard.

Flat yard tracks consist of switching leads, ladder tracks and receiving, classification, and departure tracks. Flat yards may also contain "inert" retarders on some classification tracks, locomotive and car service/repair facilities, and other buildings associated with yard operations.

TABLE 3-8

SUMMARY OF HUMP YARD DATA

Yard Characteristic	Yard Activity (Classified Cars Per Day)		
	< 1000	1000 - 2000	> 2000
Number of Classification Tracks	26	43	57
Number of Master Retarders	1	1	1
Number of Group Retarders	4	7	10
Number of Inert Retarders	26	43	57
Number of Receiving Yard Tracks	11	11	13
Number of Departure Yard Tracks	9	12	14
Standing Capacity of Classification Yard	1447	1519	2443
Standing Capacity of Receiving Yard	977	1111	1545
Standing Capacity of Departure Yard	862	969	1594
Number of Cars Classified/Day	783	1663	2661

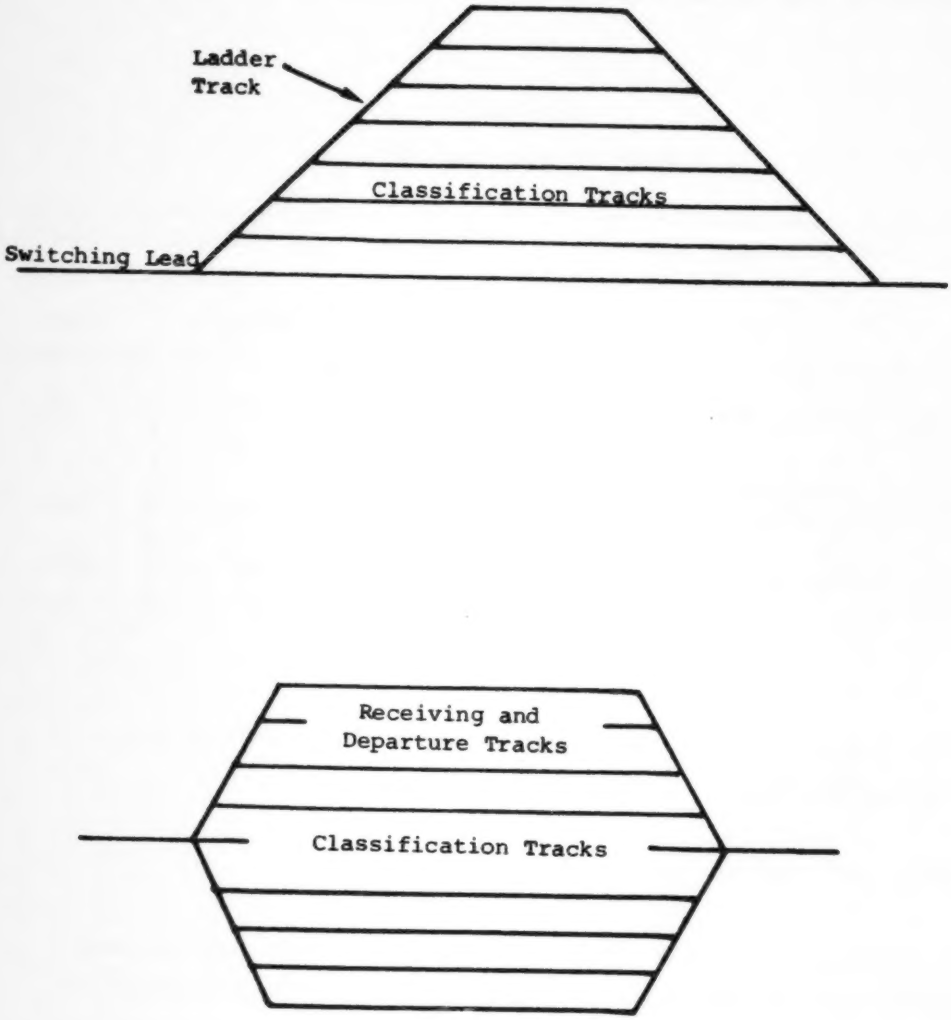


FIGURE 3-6. TYPICAL FLAT-YARD TRACK CONFIGURATIONS

Flat yard activity or capacity, measured by cars classified per day, is also a function of the number of tracks used for that function. As shown in Figure 3-7[5], this relationship is similar to that of hump yards.

Table 3-9 presents some typical data on flat yards showing yard characteristics similar to those shown for hump yards.[4]

TABLE 3-9

SUMMARY OF FLAT YARD DATA

Yard Characteristic	Yard Activity (Classified Cars/day)		
	<500	500-1000	>1000
Number of classification tracks	14	20	25
Standing capacity of classification yard	653	983	1185
Cars classified/day	348	907	1692

Flat yard operational procedures may also be found in Section 2.3 of Railroad Classification Yard Technology.[4]

SUMMARY OF RAIL YARD STATISTICAL DATA

A recent survey of the railroad system in the U.S. has resulted in valuable data regarding the railyard inventory.[4] This section presents a condensation of that data and is designed to complement the data base used in other sections of this document.

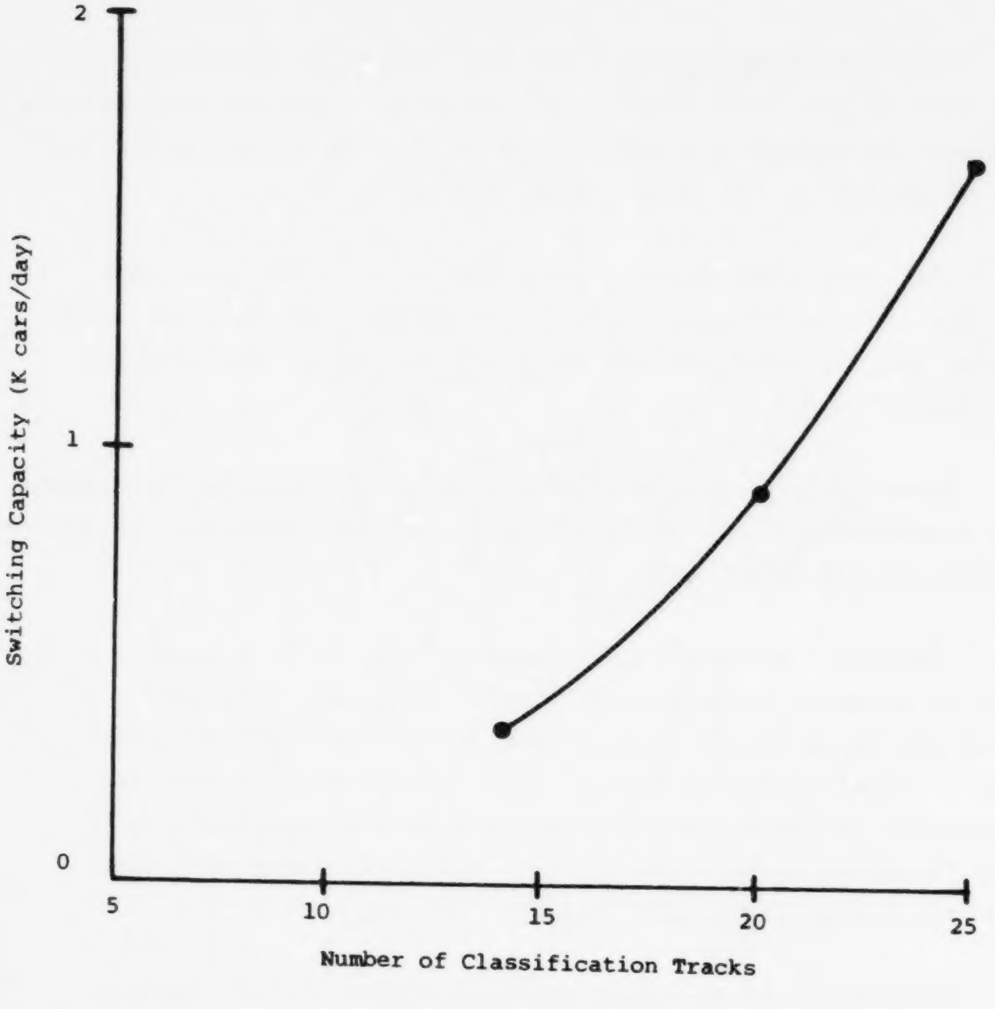


FIGURE 3-7. FLAT YARD CAPACITY

The survey concludes that there are 4169 railroad yards in the contiguous 48 states. Of these, 124 are hump yards and 4045 are flat yards. Table 3-10 displays these yards by function and adjacent land useage. These data show that the majority of yards perform the industrial service function and that only approximately five percent of the yards are used solely for car classification purposes. The data also indicate that only approximately 15 percent of the yards are located in agricultural and undeveloped areas.

Table 3-11 shows the distribution of hump yards according to yard activity and population of the yard's locality. These data show that the highest concentration of hump yards is in areas of population size two (5-50K persons) and in areas of industrial land use.

Table 3-12 shows the distribution of the 1113 flat yards used for the car classification function. These data also show that population size two and industrial areas have the highest concentration of this yard type.

Tables 3-13 and 3-14 round out the yard/population data by showing the distribution of all flat yards and all yards of both types by locality and population, respectively.

The final tabulation in this section, Table 3-15, contains a list of automatic classification yards.[6] These data show that 79 of the approximately 124 hump yards in the U.S. railroad system are automated to varying degrees. Yard automation may include the receiving, service, classification, and departure functions; car identification; switch control; speed control including car weight and rollability; and yard/car inventory and location.

Examples of the new automatic classification yards in the U.S. railroad system are Northtown (BN), Barstow (ATSF), West Colton (SP), Sheffield (SOU), and Bailey (UP).[7]

TABLE 3-10

DISTRIBUTION OF U. S. RAILROAD YARDS BY TYPE, FUNCTION, AND LOCATION

	Yard Function			
Yard Type	C/I	C	I	Total
Hump	98	18	8	124
Flat	930	183	2932	4045
Total	1028	201	2940	4169

	Adjacent Land Use By Percent					
Yard Type	I	C	R	A	U	Total
Hump	20	7	27	13	33	100
Flat	21	11	35	12	21	100
Flat Ind.	30	16	32	4	18	100
Flat Small Ind.	31	14	28	8	20	100

TABLE 3-11

DISTRIBUTION OF HUMP YARDS BY ACTIVITY AND POPULATION OF LOCALITY

Yard Activity	Population of Locality						
	1 0-5K	2 5-50K	3 50-100K	4 100-250K	5 250-500K	6 >500K	Total
Low	8	11	7	8	5	8	47
Medium	1	18	3	8	6	10	46
High	4	10	2	6	5	4	31
Total	13	39	12	22	16	22	124

TABLE 3-12

DISTRIBUTION OF FLAT YARDS USED FOR CLASSIFICATION BY ACTIVITY AND POPULATION OF LOCALITY

Yard Activity	Population of Locality						
	1 0-5K	2 5-50K	3 50-100K	4 100-250K	5 250-500K	6 >500K	Total
Low	102	219	75	60	42	73	571
Medium	64	140	48	35	23	47	357
High	33	71	23	21	12	25	185
Total	199	430	146	116	77	145	1113

TABLE 3-13

DISTRIBUTION OF ALL FLAT YARDS BY CITY POPULATION

Population of Flat Yard Locality	Yards	
	Number	Percentage
0 - 5000	1115	27
5K - 50K	1625	40
50K - 100K	366	9
100K - 250K	268	7
250K - 500K	238	6
> 500K	433	11
Total	4045	100%

TABLE 3-14

DISTRIBUTION OF ALL YARDS BY LOCALITY POPULATION

Population of Railroad Locality	Yards	
	Number	Percentage
0 - 5000	1128	27
5K - 50K	1664	40
50K - 100K	378	9
100K - 250K	290	7
250K - 500K	254	6
> 500K	455	11
Total	4169	100%

TABLE 3-15

U.S. AUTOMATIC CLASSIFICATION YARDS

Company	Location	Supplier	Year
ALS	East St. Louis, Ill	GE-GRS-WABCO	1965
ATSF	Pueblo, Colo.	WABCO	1950
	Corwith Yd., Chicago, Ill.	WABCO	1958
	Eastbound Argentine Yd., Kansas City, Mo.	WABCO	1969
	Barstow Yd., Barstow, Calif.	WABCO-ABEX-ATSF	1976
BO	Westbound Yd., Cumberland, Md.	GRS	1960
BETH STL	Burns Harbor, Ind.	GRS	1969
BN	Gavin Yd., Minot, N. Dakota	GRS	1956
	Cicero, Ill.	WABCO	1957
	Missoula, Montana	GRS	1967
	North Kansas City, Mo.	WABCO	1969
	Interbay Yd., Seattle, Wash.	ABEX	1969
	Pasco, Washington	GRS	1971
	Northtown Yd., Fridley, Minn.	GRS	1974
CO	Stevens, Kentucky	WABCO	1955
	Manifest Yd., Russell, Kentucky	WABCO	1958
MILW	Airline Yd., Milwaukee, Wis.	WABCO	1952
	Bensenville, Ill.	WABCO	1953
	St. Paul, Minn.	WABCO	1956
CR	E.B. Rutherford Yd., Rutherford, Pa.	GRS	1952
	Eastbound Conway, Pa.	WABCO	1955
	Westbound Conway, Pa.	WABCO	1957
	Frontier Yd., Buffalo, N.Y.	GRS	1957
	R.R. Young Yd., Elkhart, Ind.	GRS	1958
	Big Four Yd., Indianapolis, Ind.	GRS	1960
	Grandview Columbus, Ohio	ABEX	1964
	59th Street, Chicago, Ill.	ABEX	1966
	Pavonia, N.J.	GRS	1967
	A.E. Perlman Yd., Selkirk, N.Y.	GRS	1968
	Buckeye Yd., Columbus, Ohio	GRS	1969
DRGW	Grand Junction, Colo.	GRS	1953
DTI	Flat Rock Yd., Detroit, Mich.	ABEX	1967
DTS	Lang Yd., Toledo, Ohio	WABCO	1974
CR	Bison Yd., Buffalo, N.Y.	GRS	1963
EJE	Kirk Yd., Gary, Ind.	GRS	1952

TABLE 3-15

U.S AUTOMATIC CLASSIFICATION YARDS (Cont.)

Company	Location	Supplier	Year
ICG	Southbound Markam Yd., Chicago, Ill.	GRS	1950
	East St. Louis, Ill.	GRS	1964
IHB	Eastbound Blue Island Yd., Riverdale, Ill.	GRS	1953
LRT	Licking River Yd., Wilder, Ky.	GRS	1977
LN	Tilford Yd., Atlanta, Ga.	WABCO	1957
	Boyles Yd., Birmingham, Ala.	WABCO	1958
	Southbound DeCoursey, Kentucky	WABCO	1963
	Strawberry Yd., Louisville, Ky.	WABCO	1976
MP	Neff Yd., Kansas City, Mo.	GRS	1959
	North Little Rock, Arkansas	GRS	1962
	Centennial Yd., Ft. Worth, Texas	WABCO	1971
NW	Portsmouth, Ohio	WABCO	1953
	Bellevue, Ohio	WABCO	1967
	Roanoke, Va.	WABCO	1971
	Lamberts Point, Va.	GRS	1952
PLE	Gateway Yd., Youngstown, Ohio	WABCO	1958
RFP	Southbound Potomac Yd., Va.	WABCO	1959
	Northbound Potomac Yd., Va.	WABCO	1972
SLSF	Tennessee Yd., Memphis, Tenn.	GRS	1957
	Cherokee Yd., Tulsa, Oklahoma	GRS	1958
SSW	Pine Bluff Yd., Pine Bluff, Arkansas	WABCO	1958
SCL	Hamlet, N.C.	WABCO	1955
	East Bay Yd., Tampa, Fla.	WABCO	1970
	Rice Yd., Waycross, Ga.	WABCO	1976
SOU	Sevier Yd., Knoxville, Tenn.	GRS	1950
	Norris Yd., Birmingham, Ala.	GRS	1952
	De Butts Yd., Chattanooga, Tenn.	GRS	1955
	Inman Yd., Atlanta, Ga.	GRS	1957
	Brosnan Yd., Macon, Ga.	GRS	1966
	Sheffield Yd., Sheffield, Ala.	GRS	1973
	Piggy Back Yd., Atlanta, GA.	WABCO	1973
	Linwood Yd., Salisbury, NC.	GRS	1978
SP	Richmond, Calif.	ABEX	1964
	City of Industry, Los Angeles, Calif.	ABEX	1966
	Eugene, Oregon	WABCO	1966
	Beaumont, Texas	WABCO	1967
	West Colton, Calif.	WABCO	1973
	Strang Yd., Houston, Texas	GRS	1977

TABLE 3-15

U.S. AUTOMATIC CLASSIFICATION YARDS (Cont.)

Company	Location	Supplier	Year
TNO	Englewood Yd., Houston, Texas	GRS	1956
TRRA	Eastbound Madison Yd., Madison, Ill.	WABCO	1974
UP	North Platte, Neb. } Bailey	WABCO	1956
	North Platte, Neb.	WABCO	1968
	East Los Angeles, Calif.	GRS	1971
	Hinkle Yd., Hinkle, Oregon	GRS	1977
URR	Mon. Southern Yd., Pittsburgh, Pa.	WABCO	1954

SECTION 3

FOOTNOTES AND REFERENCES

1. Letter from Philip F. Welsh, Association of American Railroads to Henry E. Thomas, U.S. Environmental Protection Agency, November 8, 1977.

2. Final System Plan, Supplemental Report, U.S. Railway Association, September 1975.

3. The Official Railroad Equipment Register, Vol. 93, No. 2, National Railway Publication Co., New York, N.Y., October 1977.

4. Railroad Classification Yard Technology - A Survey and Assessment, Stanford Research Institute, Menlo Park, California, January 1977.

5. Railroad Classification Yard Technology - An Introductory Analysis of Functions and Operations, PB-246724, U.S. Department of Transportation, Cambridge, Mass., May 1975.

6. Automatic Classification Yards - United States and Canada, Association of American Railroads, Washington, D.C., May 4, 1977.

7. Railway Age, Vol. 179, No. 6, Simmons-Boardman Publishing Corp., Bristol, Conn., March 27, 1978.

SECTION 4

BASELINE NOISE EMISSIONS

RAILROAD NOISE SOURCES

Noise is generated by rail carriers during the operation of nearly all the equipment listed in Section 3. In order to characterize railroad noise emissions, the Agency has attempted to determine noise levels both from individual sources and from the operation of multiple sources which are combined into larger single operations such as a classification yard. The understanding of how multiple sources interact to produce an overall noise level is essential since it is the combined noise source operation which is heard by the community. A knowledge of individual equipment noise source levels is equally important since individual noise source treatment is usually the most effective method for reducing overall noise emissions. The individual sources of noise which have been identified as major contributors to railroad noise are:

- Engine noise from locomotives and switch engines
- Retarder squeal
- Refrigerator car noise
- Car-coupling noise
- Load cell testing, repair facilities and locomotive service area noise
- Wheel/Rail noise
- Horns, bells, whistles, public address systems

The primary focus in this Draft Background Document is on the above rail yard noise sources. Other railroad operations such as stations and off-yard repair facilities are minor contributors to community noise when compared to wayside noise from line operations and noise emissions from yard operations. Noise from line operations will be reviewed only briefly in this document. For more exhaustive treatment of noise from line operations the reader is referred to the December 1975 Background Document for Railroad Noise Emission Standards.[1]

RAILROAD PROPERTY NOISE SURVEY PROGRAM

The EPA has undertaken a limited noise measurement program to supplement the existing railroad noise data base and to develop baseline data at and near rail yard property lines.

This program included twenty-four hour measurements at each facility to ensure that the measured noise emissions were characteristic of the facility. Sound equivalent levels and statistical percentile levels were computed hourly. Noise correlate data such as individual noise events and distances to railroad yard noise sources were also noted during the recording period. These data, together with existing data collected previously by the EPA serve the following purposes:

- Establish the relationship of these measurements to selected rail yard, yard function, and level of activity, as a basis for the development of classification categories;
- Establish a baseline for determining the benefits afforded to the health/welfare of the nation's population by reducing noise emissions within each property classification category; and

- Select a measurement methodology, which is consistent with the health/welfare analysis and the noise emission data base, for prescribing "not-to-exceed" noise emission level standards.

MEASUREMENT METHODOLOGY

In developing a noise emission test procedure, EPA recognized the need for a relatively simple method of accurately determining noise emissions which would be suitable for enforcement auditing by the Department of Transportation and compliance determination by the railroads and local enforcement officials. A methodology was chosen consistent with the objective that it should:

- Ensure that noise emissions characteristic of major noise sources are being represented;
- Correlate well with the known effects of environmental noise upon public health and welfare; and
- Discriminate between railroad and non-railroad noise sources.

The procedure developed estimates the yearly Day-Night Average Sound Levels, (L_{dn}) at a measurement position and distinguishes whether the dominant contribution to the L_{dn} is from railroad or non-railroad properties. The measurement procedure appears in its entirety in Appendix A.

EXISTING NOISE DATA BASE

The data base for railroad noise exists in two forms. The first addresses specific railroad noise sources. These data are contained in several documents and reports.[1,2,3,4,5,6] The other form focuses on overall rail yard noise levels resulting from the combined rail yard noise sources. The rail yard noise data are contained in Appendix B.

Table 4-1 summarizes the data base for source noise levels with the principal contributors to railroad yard noise represented. These data are energy averages of the numerous data points available for each noise source.

A summary of available yard noise data is shown in Table 4-2. The table shows the range of value mesaured according to yard type and measurement location relative to the property line. The noise emissions are expressed as day/night sound levels. Rail yard noise surveys were conducted by the EPA regional representatives, consultant contractors to the EPA and a consultant contractor to the AAR. The resultant data covers measurements taken at 36 yards. The measurements were generally taken with automatic data recording equipment over a period of at least twenty-four hours. At most sites, in addition to the day/night levels, the automatic equipment provided hourly L_{eq}, L_{max}, L_1, L_{10}, L_{50}, L_{90}, and L_{99}.

As an aid to assessing the significance of the measured values, several other types of information were gathered along with the noise level data. These include data logs containing identification of the principal rail yard and non rail yard noise sources and events, maps showing measurement positions relative to yail yard property line and noise sources, and observations of the measurement teams concerning factors such as; the measurement procedures employed, the level of yard activity, the dominance of rail yard noise and the adjacent land useage. Since every yard is unique in geometry, activity, environment, etc., the correlate information is essential to interpreting the noise data. The tables presented in this section are only a summary of the noise level data. For details of the mesaurements taken at individual yards the reader should refer to Appendix B.

TABLE 4-1

NOISE SOURCE LEVEL SUMMARY

Noise Source	Number of Measurements	Level of Energy Average* $L_{Avg.}$ @100 Ft. (dBA)	SENEL @100 Ft.
Master Retarder: Group, Track, and Intermediate	410	111	108
Inert Retarder	96	93	90
Flat Yard Switch Engine Accelerating (Throttle Set 1-2)	30	83	98 (5 MPH)
Stationary Switch Engine (Throttle Set 1-2)	4	76	-
Idling Locomotive (Throttle Set 1-2)	63	63	-
Hump Switch Engine, Constant Speed (Throttle Set 1-2)	Ref. 2	78	95 (4 MPH)
Car Impact	133	100	92
Refrigerator Car	60	63	-
Load Test (Throttle 8)	59	90	-

* L_{Max}.Average for Intermittent or Moving Sources

TABLE 4-2

SUMMARY OF MEASURED NOISE LEVELS (RANGE OF L_{dn} LEVELS)

Yard Type	Inside Yard Property Line	On Yard Property Line	In Community
Hump	65-78	60-83	64-68
Flat	68-85	66-79	56-74
Industrial	-	67-78	60-67

Sample Size: 36 yards

TABLE 4-3

SUMMARY OF MEASURED LEVELS AT CLASSIFICATION YARD PROPERTY LINES ACCORDING TO YARD ACTIVITY (Range of L_{dn} Levels)

Yard Type	Yard Activity	Levels
Hump	Low	80-83
	Med	60-79
	High	60-80
Flat	Low	68-74
	Med	66-79
	High	66-76

Sample Size: 22 yards

Table 4-3 displays the available measured property line level ranges for classification yards by yard type and by yard activity. No clear relationship between yard activity category and measured L_{dn} at the property line is evident from the yards sampled.

Table 4-4 lists the yard names, railroad ownership and range of measured levels of the yards for which property line measurements were obtained. The range of measured levels is shown when more than one property line location was surveyed. In selecting the measurement locations along the property line, the measurement teams attempted to minimize the yard noise contamination due to non rail yard sources such as street traffic.

Table 4-5 shows ranges of levels for yards when measurements were taken inside the railroad property line. The selection of measurement locations inside the property line was sometimes necessary to assure that the dominant noises being measured were from the rail yards.

Table 4-6 shows measurements taken beyond rail yard property lines. Measurements taken beyond the rail yard property line tend to be more representative of the levels experienced within the community surrounding the yards. The levels experienced within the community surrounding the yards. The levels, however, frequently reflect the contributions of non rail yard sources such as street traffic.

Table 4-7 shows a sample of yard measurements with level percentiles shown during the hour of the maximum L_{eq}.

The relationship between the maximum equivalent sound level (L_{eq}) and statistical measures of noise data for the rail yards surveyed are shown in Table 4-7. The hour of occurrence for each maximum L_{eq} is also presented for all fourteen yards.

TABLE 4-4

MEASURED L_{dn} LEVELS AT RAILROAD YARD PROPERTY LINE

Yard Type	Yard Activity	Yard	Railroad	Range of L_{dn} Level	No. of Data Points
Hump	Low	Tilford	LN	80-83	6
	Med	Centennial	TP	76-79	2
	Med	Cumberland	CO	66-77	4
	Med	Corwith	ATSF	74	1
	Med	Roseville	SP	60-75	3
	High	Brosnan	SOU	60-75	4
	High	Frontier	CR	64-70	4
	High	Boyles	LN	69	2
	High	Inman	SOU	71-72	7
	High	Crest	MP	72,80est.	2
	High	Northtown	BN	67-68	3
	High	Barstow	ATSF	70-76	6
Flat	Low	Blue Isl.	RI	73	2
		Bowden	FEC	67	1
	Low	Burlington	DRGW	68-69	4
	Med	Settegast	MP	66-72	2
	Med	Morman	ATSF	70-79	2
	Med	Richmond	ATSF	71-76	3
	Med	Mays	ICP	67-73	4
	High	Eureka	MKT	74	1
	High	Dillard	SOU	66	1
	High	Barr	CHESSIE	71-76	4
Industrial		Western Ave	MILW	67-78	3

TABLE 4-5

MEASURED L_{dn} LEVELS INSIDE RAILROAD PROPERTY LINE

Yard Type	Yard	Railroad	Level
Hump	Barstow	ATSF	62-78
	Crest	MP	78-88
	Cicero	BN	78-81
	Northtown	BN	65-74
	Enola	Conrail	67-77
Flat	Johnson	ICG	75-85
	E. Dallas	ATSF	68-69
	Settegast	MP	68
	Dillard	SOU	73-77

TABLE 4-6

MEASURED L_{dn} LEVELS BEYOND RAILYARD PROPERTY LINE

Yard Type	Yard	Railyard	Level
Hump	Argentine	ATSF	64 @ 200'
	Potomac	RFP	68 @ 650'
Flat	Eureka	MKT	56-65 unknown
	Blue Island	RI	72-74 @ 270'
	West Springfield	CR	69 @ 60'
	Forrest	SOU	60 @ 320' 67 @ 120'
	Denver	DRGW	64-73 unknown
	E. Deerfield	CR	61 @ 100'
	Morman	ATSF	68-71 unknown
	Interbay	BN	65, 65 @ 250' 70 @ 350' 62 @ 750'
Industrial	Readville		60 @ 62'
	Fort Lauderdale		67 @ 63'

TABLE 4-7

MEASURED NOISE LEVELS DURING HOUR OF MAXIMUM L_{eq} ACCORDING TO YARD TYPE

Yard Type	Yard Activity	Yard	RR	Hour of Max. L_{eq}	Max. L_{eq}	L_0	L_1	L_{10}	L_{50}	L_{90}	L_{99}
Flat	Low	Denver	UP	08-09	74	105	86	57	54	52	
				18-19	74	102	89	57	52	50	
	Low	Burlington	DRGW	15-16	69	95	81	64	57	54	
				17-18	69	96	81	59	48	44	
	Medium	Settegast	MP	17-18	75	90	88	80	54	52	50
	Medium	Mays	ICG	01-02	74	95	80	67	56	48	46
	Medium	Richmond	ATSF	17-18	80	112	71	46	40	33	24
	High	E. Dallas	ATSF	16-17	68	93	80	65	60	58	
				14-15	68	98	80	64	60	58	
	High	Dillard	SOU	23-24	76	98	88	71	52	46	44
	High	Johnston	ICG	00-01	88	122	77	67	66	66	66
Hump	Low	Tilford	LN	00-01	81	106	94	72	61	58	
				22-23	81	105	94	80	65	57	
	Medium	Centennial	TP	19-20	81	105	94	81	57	51	
					81	108	94	76	57	55	
	Medium	Barstow	ATSF	00-01	77	97	88	77	62	57	54
	Medium	Roseville	SP	08-09	79	101	94	74	60	54	52
				15-16	79	109	93	73	54	50	48
	High	Brosnan	SOU	16-17	72	91	84	73	62	52	43
	High	Inman	SOU	13-14	70	92	81	69	66	59	
				22-23	70	96	76	67	62	59	

Average equivalent sound levels (L_{eq}) for daytime and nighttime operations in each yard are summarized in Table 4-8. Daytime operations cover from 0700 to 2200 hours. Night operations are from 2200 to 0700 hours of the next day. Examination of these data reveals that for the yards sampled sound levels from nighttime operations are approximately equal to those from daytime operations.

Variations in property line L_{dn} noise levels experienced over a number of measurement days are shown in Table 4-9. This information indicates that yard noise level does not appear to fluctuate appreciably from day to day. It should be noted, however, that the available data base for these variations is not large and that seasonal effects may not be accurately represented.

TABLE 4-8

COMPARISON OF DAY AND NIGHT SOUND LEVELS AT SELECTED RAILROAD YARD PROPERTY LINES

Yard Type	Yard Activity	Yard	Railroad	L_{eq} Day*	L_{eq} Night**
Hump	Low	Tilford	LN	76	77
	Med	Centennial	TP	74	73
	Med	Cumberland	CO	69	69
	Med	Corwith	ATSF	68	68
	Med	Roseville	SP	57 67	55 68
	High	Brosnan	SOU	62	59
	High	Frontier	CR	62	64
	High	Boyles	LN	65	63
	High	Inman	SOU	64	65
	High	Crest	MP	80	82
	High	Barstow	ATSF	64	66
Flat	Low	Blue Isl.	RI	66	68
	Low	Burlington	DRGW	62	63
	Med	Settegast	MP	67	65
	Med	Morman	ATSF	63	64
	Med	Richmond	ATSF	72	68
	Med	Mays	ICP	58	61
	High	Eureka	MKT	69	67
	High	Dillard	SOU	63	58
	High	Barr	CHESSIE	65 65	65 66
Industrial		Western Ave	MILW	74	70

* 0700-2200 hours

** 2200-0700 hours

TABLE 4-9

DAILY VARIATION IN DAY-NIGHT AVERAGE SOUND LEVELS AT SELECTED CLASSIFICATION RAIL YARD PROPERTY LINES

Rail Yard	Operator	Yard Capacity	Yard Type	No. of Measurement Days	Variation in L_{dn} Values (dB)
Tilford	LN	Low	Hump	6	3
Cumberlad	CO	Med	Hump	2	1
Centennial	TP	Med	Hump	2	3
Roseville	SP	Med	Hump	2	1
Brosnan	SOU	High	Hump	2	2
Inman	SOU	High	Hump	7	1
Frontier	CR	High	Hump	2	1
Northtown			Hump	3	1
			Hump	3	1
			Hump	3	3
Barstow	ATSF	High	Hump	2	4
Burlington	DRGW	Low	Flat	4	1
Morman	ATSF	Med	Flat	2	9

SECTION 4

REFERENCES

1. Background Document for Railroad Noise Emission Standards, EPA 550/9-76-005, U.S. Environmental Protection Agency, Washington, D.C., December 1975.

2. Assessment of Noise Environments Around Railroad Operations Jack W. Swing and Donald B. Pies, Wyle Laboratories, Contract No. 0300-94-07991, Report No. WCR 73-5, July 1973.

3. Measurement of RR Noise-Line Operations, Boundaries, and Retarders, J. M. Fath, et. al., National Bureau of Standards, for EPA, December 1974.

4. Noise Level Measurements of Railroads Freight Yards and Wayside, Transportation Systems Center, E. J. Rickley, et. al., DOT-TSC-OST-73-46, Final Report, PB 234 219 May 1974.

5. Rail and Environmental Noise: A State of the Art Assessment, Bender, E. K., et. al., Bolt, Beranek and Newman, #2709, 105 pp., January 1974.

6. Diesel-Powered Heavy-Duty Refrigeration Unit Noise, Thomas J.. Retka, #DOT-TSC-OST-75-5, Final Report, January 1976.

SECTION 5

NOISE CONTROL TECHNOLOGY

INTRODUCTION

The major sources of railroad noise and the alternative abatement procedures for reducing noise emissions from the sources were investigated by the EPA prior to issuing noise emission standards for rail cars and locomotives in January 1976. A brief summary of the sources and treatments is included in this document. A more comprehensive analysis can be found in the Background Document for the Railroad Noise Emission Standards, December 1975[1]. In considering the noise control technology available to reduce railroad noise emissions, it is necessary to consider also the alternative regulatory approaches which might be employed in developing a noise emission standard. For example, a source-type standard requires that individual noise sources meet specified "not-to-exceed" levels which are generally based on best available technology, taking into account the cost of compliance. For a property line-type standard, individual noise sources do not have fixed "not-to-exceed" levels. Thus, for a property line standard, available technology requires only that total noise emissions from the operations of all equipment on the property not exceed a specified level at each point along the property line or the adjacent receiving land. It is clear that the options available to meet a property line-type standard include operational procedures such as rescheduling of activities and relocation of noise sources; and alternatives such as land acquisition to provide a buffer zone from the railroad noise sources.

DESCRIPTIONS OF YARD NOISE SOURCES AND ABATEMENT TECHNOLOGY

Locomotives and Switch Engines

Over 99 percent of the trains in the United States are hauled by diesel-electric locomotives. A few trains, particularly in the Northeast corridor, are powered by all-electric or gas turbine locomotives. The few remaining steam locomotives in the United States are preserved primarily as historical curiosities.

Diesel-electric locomotives have a diesel engine driving an electric alternator or generator which, in turn, drives electric traction motors on the wheels. The electrical system acts as an "automatic transmission" and, in a given throttle setting, maintains a constant load on the engine for differing train speeds. The operation of diesel-electric locomotives represents a major source of the noise emitted from yards. The major noise-producing mechanisms in diesel-electric locomotives are engine exhaust, engine casing vibrations, and cooling fans.

Noise abatement for locomotives and switch engines can be accomplished by the following approaches:

- Equipment modification
  - Improved exhaust muffling
  - Cooling fan modification
  - Engine shielding
- Operational procedures
  - Park idling locomotives closer to center of the yard or away from residences
  - Reduce speed
  - Reduce nighttime operations.

Retarders

Within the classification portion of most major U.S. hump yards, retarders are used to control the velocity of free-rolling freight cars.

The speed with which the cars enter the classification track must be controlled, so that the impact at the destination is just sufficient to ensure coupling. The master retarder at the entrance to the switching zone provides velocity control and spacing between the cars, while the group retarders at the entrance to each group of classification tracks bring the cars to the speed required for final coupling.

The retarders are mechanical devices which clamp a beam against the wheel of the cars, thereby creating a friction force which slows the forward motion of the cars. The retardation is controlled by varying the pressure applied to the beam. The friction force, in addition to controlling the rail car retardation, can produce and radiate an intense squealing noise.

Three approaches for reducing the noise emissions from retarder squeal have been developed and are currently in use. The methods are:

- Barriers
- Lubrication systems
- Ductile iron shoes.

Barriers have proven effective at the Madison Yard, operated by the Terminal Railroad Association of St. Louis. These barriers are twelve feet high, measured from the top of the rail, with the peak of the barriers eight feet on a perpendicular line to the rail track center. The barrier's construction consists of supporting timbers, corrugated transite, and four inch fiberglass absorptive material with protective covering. Noise measurements before and after barrier installation showed that the noise levels were reduced up to 25 dB. Similar measurements conducted as part of a research project at the Burlington Northern Railroad[2], Northtown freight yard showed insertion loss values of 16 dB to 22 dB. Figures, 5-1, 5-2, and 5-3 show how sound levels vary as a function of barrier, height, absorptive characteristics and distance from the barriers.

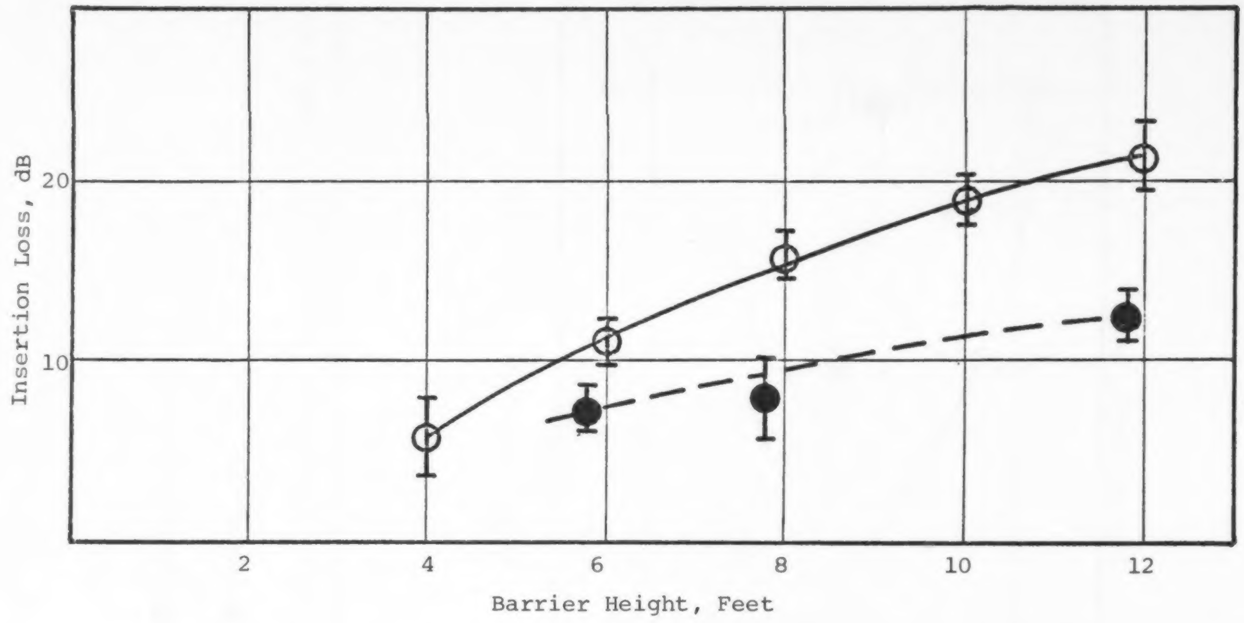


FIGURE 5-1. INSERTION LOSS OF RETARDER BARRIER AS A FUNCTION OF BARRIER HEIGHT (100 FEET FROM BARRIER AT 90 DEGREES)

○ ABSORPTIVE

● REFLECTIVE

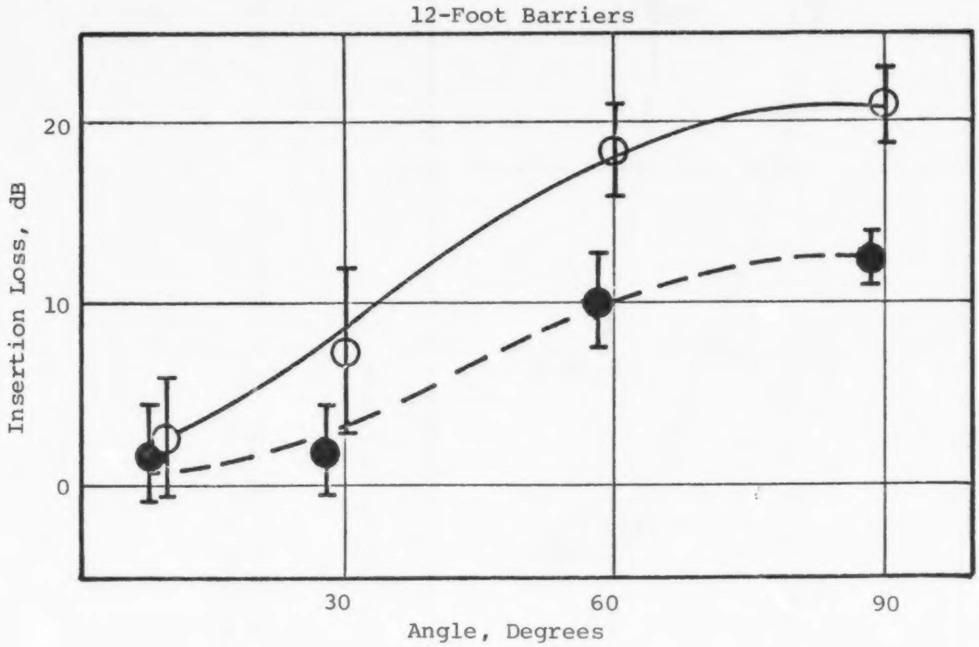


FIGURE 5-2. INSERTION LOSS OF 12-FOOT BARRIERS, AS A FUNCTION OF ANGULAR LOCATION (100-FOOT EQUIVALENT DISTANCE)

● ABSORPTIVE

● REFLECTIVE

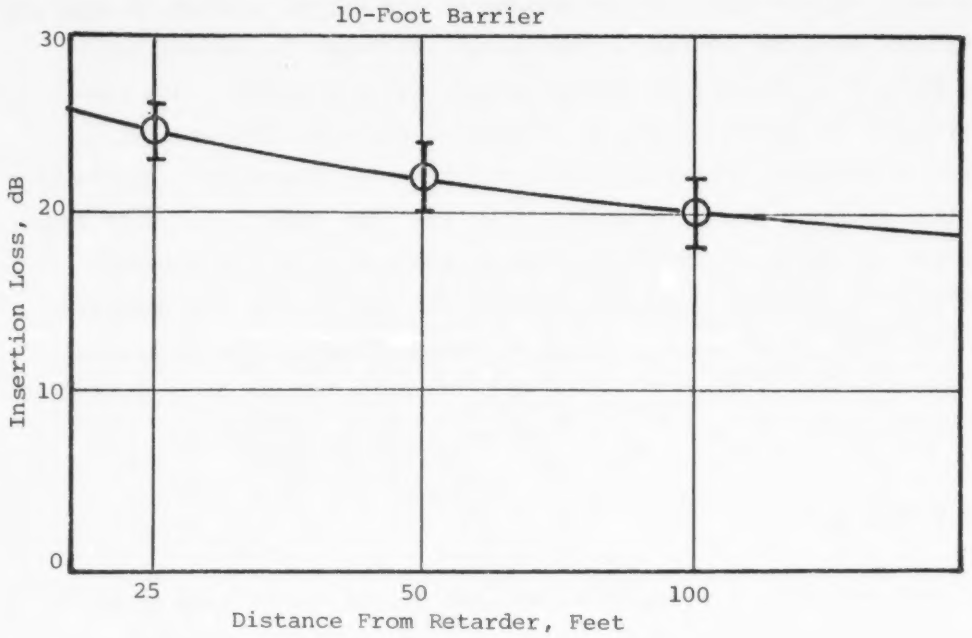


FIGURE 5-3. INSERTION LOSS OF A 10-FOOT HIGH ABSORPTIVE BARRIER AS A FUNCTION OF THE DISTANCE FROM THE RETARDER TO THE OBSERVER AT 90 DEGREES

Lubrication systems are currently being employed by Burlington Northern at their Northtown yard. The lubrication system consists of a series of nozzles on a header pipe running down both sides of each rail with a concrete trough below the rail to collect the runoff. A water soluble oil solution of less than two percent oil is employed. A mixture of ethylene glycol is added in winter to keep the water from freezing. The lubricant is collected in a retrieval system and cleaned for reuse. Approximately three gallons of the dilute mixture is used per car sprayed when the system is operating. At least 50 percent and maybe as high as 75 percent of the mixture is recoverable. The consumption of oil may be as low as 75 gallons per day. The system eliminates retarder squeal as a significant noise source by reducing the frequency of the stick-slip action. Ductile iron shoes, cast with free spheroidal graphite dispersed throughout the metal, are also being employed to reduce the frequency of retarder squeal. At the Southern Pacific's West Colton yard[3], squeal frequency dropped from 53 percent with the standard steel shoes to 17 percent with ductile iron (inside shoe only).

Inert Retarders

Inert retarders are generally located at the end of each track used for classification. Their function is to hold the block of cars being assembled from rolling out of the bottom of the yard. Inert retarders are either constant retardation spring-type or the self-energizing, weight sensitivity controlled-type. A squeal is produced when a block of cars is being pulled out of the classification tracks so that the duration of squeal from the inert retarder is considerably longer than that of the master or group retarder. Noise from inert retarders can be eliminated by replacing inert retarders with commercially available releasable-type retarders which allow cars to pass freely when the release is activated.

Car Coupling Noise

Car impacts constitute one of the most randomly distributed sources of noise in the railroad yard. As a railroad car rolls along the track into the classification yard, it may be stopped by an inert retarder, collide with a stationary car, collide with a string of cars coupled to the restrained car (causing a chain reaction of impacts), or it may overtake one or more cars that are not restrained.

The noise level produced in car-car impacts varies according to the different configurations, relative speed of cars, type of cars, type of couple (cushioned or non-cushioned), weight of cars, size and weight of load. Little is known about the contribution of each of these factors to the total car-coupling noise level, however, the relationship of car speed to total coupling noise has been measured for a number of simulated operating conditions. The results are presented in Appendix N. Practical approaches to reducing coupling noise may be limited at present to keeping car speeds to minimum levels required for coupling and reducing nighttime classification operations in residential areas.

Refrigerator Cars

The railroad industry has gradually been changing over from block ice-cooled perishable transport cars to closed-system, diesel engine-driven, mechanical-refrigerator cars. While awaiting transit, refrigerator units are kept running continuously. During this period, they are often parked near the perimeter of rail yards in large blocks consisting solely of these units.

The required technology for reducing noise emissions from mechanical refrigerator cars has been applied to truck and trailer-mounted refrigeration units.[4] It consists of a better muffler for the diesel engine and the application of sound-absorptive foam.

Repair Facilities, Load Cell Testing and Locomotive Service Areas

In the United States there are approximately 216 locomotive and repair facilities located on or in close proximity to yards. When diesel-electric locomotives undergo major engine service or repair, they are generally subjected to a series of static performance tests and inspections. These tests include engine performance under load. Locomotives can be load tested at all throttle settings including full power by routing the electrical power generated into resistor banks termed "load boxes" adjacent to the test site. This load test is usually conducted in the service rack facility, generally in the vicinity of the engine shop area. Load test facilities are operated on a 24-hour per day basis.

In addition to the repair facilities, the locomotives go through a routine maintenance inspection at a service area. This servicing primarily includes washing, sanding, fueling and analysis of the lube oil. Other minor underbody inspections and lubrications may also be performed. The main source of noise at the service and repair areas can be attributed to the idling locomotives clustered in the facility at any given time.

Reducing noise impacts from repair facilities, and load cell testing and service areas, which currently are causing impacts, may require construction of large barriers or enclosure of the testing area. Where enclosure or barriers are impractical because of the size of the area, relocation of the test area to greater distances away from property lines will reduce property line noise levels.

Wheel/Rail Noise

The four main sources of wheel/rail noise are: squeal, impact, roar and flange rubbing. The major wheel/rail noise emissions are associated with mainline operation and have levels which increase with train speed; however, wheel squeal is occasionally a yard problem and can occur at very slow speeds. Wheel squeal and flange rubbing occur when a train negotiates a tight curve.

The squeal noise from tight curves in yards can be mitigated by use of automatic rail oilers, and local barriers along tight curves.

Miscellaneous Sources

Railroad yards contain various miscellaneous sources of noise. Among these are loudspeakers, horns, and whistles. These noises are different in nature from most other types of railroad noise because they are primarily used intentionally as warning devices to convey information to the receiver rather than being unwanted by products of some other activity. They are regulated at the Federal and State levels as safety devices rather than noise sources.

Table 5-1 summarizes the techniques for reducing noise emissions and the estimated noise level reduction for major noise sources in railroad yards. Miscellaneous yard activities and equipment including rail repair, use of maintenance equipment, generators, motors, etc., help constitute a general ambient level which can be lowered by treating individual sources with the techniques listed.

Other techniques generally applicable to all noise sources that might effecively reduce noise impacts are:

- Rescheduling of activities so that major noise emissions do not occur at nighttime (10 p.m. - 7 a.m.). Turning off equipment not in use.

- Relocation of noise-source activities to areas away from property lines and noise sensitive zones.

- Extension of property line beyond existing property lines in order to create buffer zones around noisy areas.

- Replacing old or noisy equipment with new quieter equipment.

- Modification of structures subjected to noise impact (residences, hospitals, etc.).

TABLE 5-1

TREATMENT AND NOISE SOURCE LEVEL REDUCTION

NOISE SOURCE	TREATMENT	ESTIMATED NOISE LEVEL REDUCTION (dB)
Retarder (master & group)	Barriers	16-22*
	Lubrication Ductile iron shoes	Reduces no. of car squeals
Inert retarders	Replace non-releasable type	Eliminates retarder squeal
Locomotives	(currently regulated)	
Moving switch engine (throttle set 1-2)	Exhaust muffling Cooling fan treatment	4
Idling switch engines (throttle set 0)	Exhaust muffling Cooling fan treatment	3
Car coupling impact	Reduce car speed	
Refrigerator car	Exhaust muffler, partial enclosure	4
Repair facilities/ Load testing	Enclose facility, Relocate facility	25
Wheel/rail at tight curves	Barrier	10-20

* Insertion loss perpendicular to barrier at 100 ft.

The abatement technology which has been described is proven technology that is currently available "off the shelf" or with short lead times. The actual lead times for application of the technology will depend more on planning by rail carriers and on the availability of labor and rail equipment requiring retrofit. Abatement measures such as rescheduling of nighttime activities and construction of local barriers could most likely be accomplished in less than a year, however, measures requiring difficult scheduling, for example, retrofit of all refrigerator cars and switch engines could take up to five years if operating disruptions are to be avoided.

NOISE CONTROL TO ACHIEVE ALTERNATIVE REGULATORY STUDY LEVELS

Four alternative property line study levels have been examined as potential regulatory levels:

Day-Night Level (dB)

- Level 1 - 75
- Level 2 - 70
- Level 3 - 65
- Level 4 - 60

The levels are "not-to-exceed" day-night average sound levels measured at the property line.

In estimating the degree of noise control required to achieve the alternative regulatory study levels, it is necessary to determine the major noise sources within each yard category and the contribution of these sources to the property line L_{dn}. The assignment of railroad noise sources to various rail yard categories is developed in detail in Section 6 in the rail yard model developed for determining noise impacts.

Note: In order to complete the technology and cost background studies in the short time that was available, the noise abatement analysis was conducted using a preliminary version of the rail yard model presented in Section 6. Several differences exist between rail yard model features used for the technology/cost analysis and those used for the noise impact analysis in Section 6. These differences are related to the grouping of sources to form independent noise source centers, noise source to property line distances and the rail yard equipment activity levels.

For the purposes of noise abatement determination and cost analysis a reduced number of categories are distinguished. Industrial and small industrial yards have been lumped into a single category since they contain identical noise sources and are estimated to have almost the same property line levels. Table 5-2 shows the yard categories and corresponding noise sources used for the noise abatement and cost analysis. Table 5-3 shows the estimated average of current maximum L_{dn} property line levels for yards in each category and the L_{dn} reduction required to achieve each of the four property line study

TABLE 5-2

RAIL YARD NOISE SOURCES AS A FUNCTION OF YARD CATEGORY

YARD CATEGORY	NOISE SOURCE
Hump	Retarders (Group & Master) Hump Switchers Inert Retarders Makeup Switchers Car Impacts Load Tests Idling Locomotives Refrigerator Car Industrial Switchers Outbound Trains Inbound Trains
Flat (Classification)	Classification Switchers Car Impacts Inbound Trains Outbound Trains Idling Locomotives Load Tests Refrigerator Cars
Flat (Industrial/ Small Industrial)	Switch Engines Car Impacts Inbound Trains Outbound Trains

TABLE 5-3

ESTIMATED EQUIVALENT DAY-NIGHT SOUND LEVEL REDUCTION REQUIRED IN RAILROAD YARDS

YARD CATEGORY	ESTIMATED PROPERTY LINE LEVEL* (dB)	L_{dn} REDUCTION TO ACHIEVE LEVELS			
		LEVEL 1 (75 dB)	LEVEL 2 (70 dB)	LEVEL 3 (65 dB)	LEVEL 4 (60 dB)
Hump Yards					
Low Activity	80	5	10	15	20
Medium Activity	79	4	9	14	19
High Activity	80	5	10	15	20
Flat Classification Yards					
Low Activity	74	-	4	9	14
Medium Activity	78	3	8	13	18
High Activity	76	1	6	11	16
Industrial/Small Industrial Flat Yards	71	-	1	6	11

*Maximum L_{dn} value along property line levels. Two types of data were used to develop estimates of the property line levels. These were: (1) the measured property line levels, and (2) the predicted property line levels from the propagation model presented in Section 6. Each yard type has a range of L_{dn} values for each type of data. The estimated property line levels are selected from the overlapping ranges of predicted and measured property line L_{dn} values. The approach estimates somewhat higher property line levels for "typical" yards than the levels indicated by the measured property line values. It is realizd that yards vary considerably in their configuration and that no yards are "typical". Thus, any given yard may have measured property line levels which differ significantly from the estimated property line level for a typical yard.

The analysis of property line levels (both measured and predicted) by yard activity classification shows little variation of property line levels with yard type by activity. As can be seen in Table 4-3 the rail yards selected to represent high volume classification yards had measured property line levels which were not significantly different from those of the other measured yards. Apparently, the reason for this is that yards designed for high volumes of traffic have greater distances from the noise sources to the property lines than do other yards. This inverse relationship between yard activity and source distance to property line appears confirmed by the detailed analysis of photographs of approximately 120 yards (see analysis of EPIC survey data - Section 6). The data, therefore, suggest that there would be little difference in the types of treatments associated with abating noise for yards from differing activity categories but of a similar yard type.

In Table 5-4, the various abatement procedures described earlier in this section are shown in combination to achieve the required L_{dn} reduction for each study level. Land acquisition is considered as an alternative and has not been considered in combination with the other abatement procedures. Many alternative combination of abatement techniques can also achieve the required property line noise level

TABLE 5-4

ABATEMENT PROCEDURES FOR ACHIEVING STUDY LEVELS IN YARDS*

YARD TYPE	STUDY LEVEL	ABATEMENT PROCEDURES**									
		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}
Hump	Level 1	X									
	Level 2	X				X	X		X	X	
	Level 3	X		X	X	X	X		X	X	
	Level 4	X	X		X	X	X	X	X	X	X
Flat (Classification)	Level 1					X	X		X		
	Level 2					X	X		X	X	
	Level 3					X	X	X	X	X	X
	Level 4					X	X	X	X	X	X
Flat (Industrial/Small Industrial)	Level 1	(Current L_{dn} below Level 1)									
	Level 2						X				
	Level 3						X				X
	Level 4						X				X

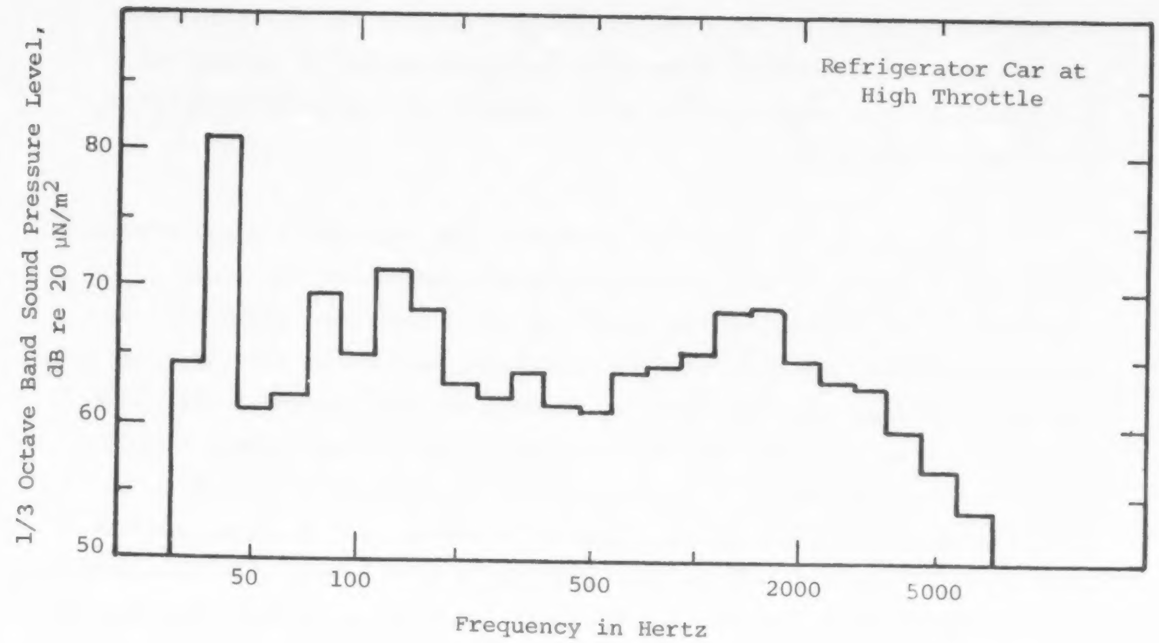
* Medium level of activity

** Code symbols

T_1	Retarder Barriers
T_2	Lubrication of Retarders
T_3	Ductile Iron Shoes
T_4	Replace Non-Releasable with Releasable Inert Retarder
T_5	Refrigerator Car Treatment
T_6	Switch Engine Treatment
T_7	Enclose Facility (Engine repair, car services)
T_8	Relocate Structure/Load Test Site
T_9	Relocate or Shut Down Idling Locomotive
T_{10}	Reschedule to Reduce Nighttime Activities and/or Number of Classifications.

reductions. The amount of noise abatement required and the techniques which would be selected at a specific rail yard would, of course, be determined by the noise sources, yard geometry and operational factors peculiar to that yard.

In addition to the potential property line regulatory study levels, individual major rail yard noise sources are candidates for source regulation. Noise sources for which the noise abatement technology is well established, e.g., noise from retarders, mechanical refrigeration cars and car coupling, could be required to meet specific cource levels independent of property line regulatory levels. Such a requirement would recognize the fact that the L_{dn} descriptor is inadequate for characterizing annoyance from certain types of sources. For example, sources such as retarders and refrigerator cars which have large, pure-tone components (see Figure 5-5) can be especially annoying even when they are not affecting ambient levels appreciably. Likewise, impact noise from car coupling can be a major cause of annoyance while contributing little to L_{dn}. Recent studies conducted for the EPA indicate that the maximum car impact noise from coupling is a function of coupling speed. The study data (See Appendix N) indicate that 95 dBA is the maximum level observed at 30 meters for car coupling speeds of approximately 4 mph. Using the treatment summarized in Table 5-1, it is estimated that levels of individual sources could be reduced as shown in Table 5-5.



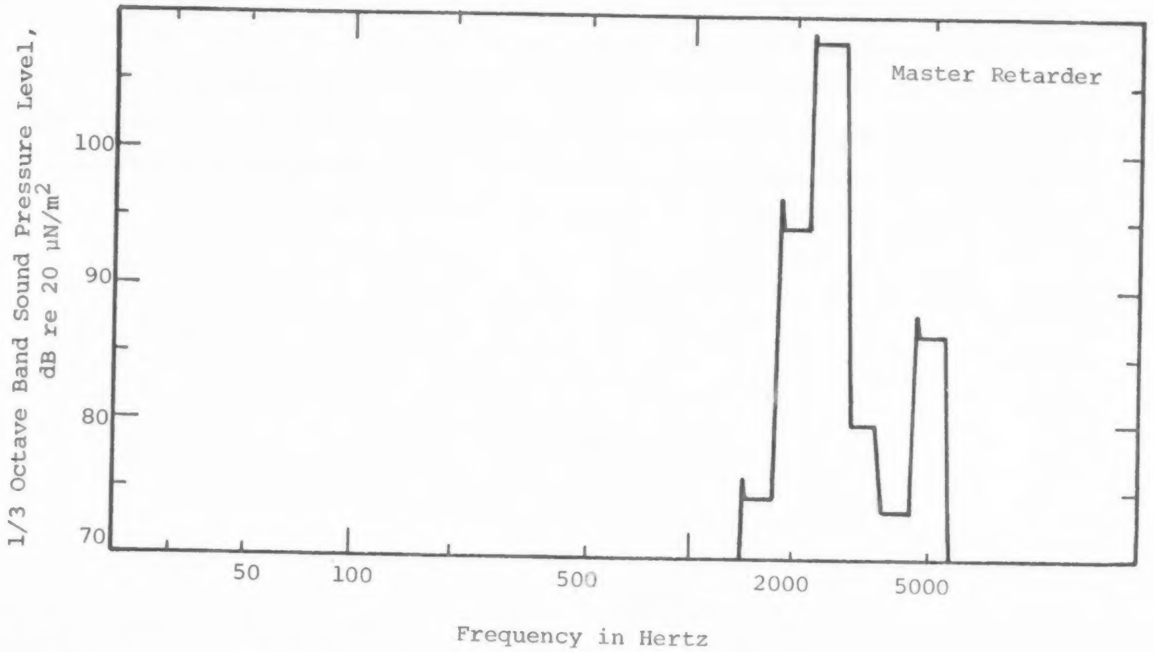


FIGURE 5-4 FREQUENCY SPECTRUM OF NOISE EMITTED FROM MASTER RETARDER (at 100 ft.) AND MECHANICAL REFRIGERATOR CAR (at 50 ft.).

TABLE 5-5

NOISE SOURCE LEVEL REDUCTION

Noise Source	Level* (dBA) at 100 feet	Reduced Level (dBA) at 100 feet
Retarders (master and group)	111	90
Inert retarder	93	0
Moving switch engine (throttle set 1-2)	83	79
Idling switch engine (throttle set 0)	69 at 50'	66 at 50'
Refrigerator car	69 at 50'	65 at 50'

* L max. average for intermittent or moving source

SECTION 5

REFERENCES

1. Background Document for Railroad Noise Emission Standards, EPA-550/9-76-005, U.S. Environmental Protection Agency, Washington, D.C., 1975.

2. Railroad Retarder Noise Reduction, Burlington Northern Inc. and Transportation Systems Center, Cambridge, Massachusetts, on-going study.

3. Private communication, Mr. Rudy Nagal, Signal Department, Southern Pacific Railroad, April 3, 1978.

4. Noise Control Technology for Truck-Mounted Refrigeration Units, BBN Report No. 3264, Submitted to the U.S. Environmental Protection Agency, March 1976.

SECTION 6
HEALTH AND WELFARE IMPACT

INTRODUCTION

Benefits to Public Health and Welfare

The phrase "health and welfare", in the analysis and in the context of the Noise Control Act, is a broad term. It includes personal comfort and well-being, and the absence of mental anguish, disturbances and annoyance, as well as the absence of clinical symptoms such as hearing loss or demonstrable physiological injury. In other words, the term applies to the entire range of adverse effects that noise can have on people, apart from economic impact.

Improvements in public health and welfare are regarded as benefits of noise control. Public health and welfare benefits may be quantified both in terms of reductions in noise exposures and, more meaningful, in terms of reductions in adverse effects. This analysis first quantifies rail facilitiy noise exposure (numbers of people exposed at different noise levels), then translates this exposure into a community impact.

Noise Exposure

People are exposed to noise from rail facilities in a variety of situations. Some examples are:

1. Inside a home or office
2. Outdoors at home, or near commercial and industrial areas
3. As a pedestrian, or participant in recreational activities

In this analysis, no attempt was made to quantify the complexities of rail noise exposures of people moving from environment to environment and activity to activity. Instead, the analysis quantifies residential noise levels and numbers of residents living in each different level of noise environment. This is appropriate to a quantification of a community's general adverse response to rail facililty noise.

Effects of Noise on People

Noise affects people in many ways, although not all noise effects will occur at all levels. Rail facility noise may or may not produce the effects mentioned below, depending on exposures and specific situations. The discussion here refers to noise in general.

The best-known noise effect is probably noise-induced hearing loss. It is characteristic of noise-induced hearing loss that it first occurs in a high-frequency area of the auditory range which is important for the understanding of speech. As a noise-induced hearing loss develops, the sounds of speech which lend meaning become less and less discriminable. Eventually, while utterances are still heard, they become merely a series of low rumbles, and the intelligibility is less. Noise-induced hearig loss is a permanent loss for which hearing aids and medical procedures cannot compensate.

Moreover, noise is a potent stressor. The body has a basic, primitive response mechanism which automatically responds to noise as if to a warning or danger signal. A complex of bodily reactions (sometimes called the "flight-or-fight" response) takes place which is beyond conscious control. When noise intrudes, these reactions include elevation of blood pressure, changes in heart rate, secretions of certain hormones into the bloodstream, changes in digestive processes, increased perspiration on the skin and many others.

This stress response occurs with individual noise events, but it is not known yet whether the reactions seen in the short term become, or contribute to, long-term stress disease such as chronic high blood pressure. Therefore, the stress response to noise cannot yet be quantified.

On the other hand, some of this stress response may be reflected in what people express as "annoyance", "irritation", or "aggravation". This analysis does quantify the generalized adverse reaction of groups of people to environmenmtal noise. To the extent that stress and verbalized annoyance are related, the "general adverse response" quantity may be seen to partially represent or indicate the magnitude of stress response.

The general adverse response relationship to noise levels may also be seen as partially representing another area of noise effects: activity interference. Noise interferes with many important daily activities such as sleep and communication. These effects (sleep disturbance and communication interference) can be quantified, as can hearing loss, but time and resources prohibited these calculations from being made. In expressing the causes of noise annoyance, people often report that noise interferes with sleeping, relaxing, concentration, TV and radio listening, and face-to-face and telephone discussions. Thus, the general adverse response quantity may be seen also as indicative of the severity of interference with activities.

Magnitude of Noise Effects

Because of inherent differences in individual response to noise, the wide range of rail facility configurations and environments, and the complexity of the associated noise fields, it is not possible to examine all situations precisely. Hence, in this predictive analysis, certain stated assumptions have been made to approximate typical, or average, situations. The approach taken to determine the benefits associated with the noise regulation is therefore statistical, in that an effort is made to determine the order of magnitude of the population that may be affected at each study level. Some uncertainties with respect to individual cases or situations will remain.

In general, reducing noise levels at the boundary of rail yard facilities is expected to produce the following benefits:

1. Reduction in overall rail yard site noise levels and associated cumulative long-term impact upon the exposed population.

2. Fewer activities disrupted by individual, intense noise or intruding noise events.

3. General improvement in the quality of life, with quietness as an amenity resource.

The approach taken for the analysis was to evaluate the effects, in terms of the percentage change in the impact of rail yard noise, on the U.S. population resulting from reduction of noise levels at rail yard boundaries by reducing the noise levels of the predominant noise sources found in rail yards. Another predominant source of railroad operation impact, line-haul noise (locomotives and rail cars) is currently subject to Federal noise emission regulations.[7]

Health and Welfare Impact Measures

The health and welfare impact analysis utilizes a noise measure that integrates the sound pressure or energy fluctuations of the noise environment into a simple indicator of both sound energy magnitude and duration. This general measure for environmental noise is the equivalent or average A-weighted sound (noise) level, in units of decibels. The general symbol for equivalent sound level is L_{eq}. This indicator correlates well with the overall long-term effects of noise on the public health and welfare, and its use has increased as a result of the Noise Control Act of 1972, which required EPA to present information on noise levels "requisite to protect the public health and welfare with an adequate margin of safety." The analytical expression for L_{eq} is:

$$L_{eq} = 10 \log_{10} \left[\frac{1}{t_2 - t_1} \int_{t_1}^{t_2} \frac{p^2(t)}{p^2_o} \, dt \right]$$

where $t_2 - t_1$ is the interval of time over which the pressure levels are evaluated, $p(t)$ is the time varying sound pressure of the noise, and p_o is a standard reference pressure (20 micropascals). When expressed in terms of an A-weighted sound level, the equivalent sound, level (L_{eq}) is expressed by:

$$L_{eq} = 10 \log_{10} \left[\frac{1}{t_2 - t_1} \int_{t_1}^{t^2} 10^{L(t)/10} \, dt \right]$$

where, in general, $L(t) = 10 \log_{10} \left[\frac{p(t)}{p_o} \right]^2$

The impact of the daily noise environment on people is assesed in terms of the day-night average sound level (L_{dn}) which is a noise rating scale developed by the EPA. L_{dn} is used as a rating scale for the daily (24-hour) sound exposure and incorporates a weighting factor applied to nighttime noise levels to account for the increased sensitivity or reaction of people to noise intrusion at night. Thus, L_{dn}

is defined as the equivalent sound level during a 24-hour period, with a 10 dB weighting applied to the noise exposure or levels for the noise events during the nighttime hours of 10 P.M. to 7 A.M. This may be expressed by the following equation:

$$L_{dn} = 10 \log_{10} \frac{1}{T} \left\{ \int_{t_1}^{t_2} 10^{L(t)/10} \quad dt + \int_{t_2}^{t_3} 10^{[L(t)+10]/10} \cdot dt \right\}$$

$T=t_3-t_1$, $t_1=7$ A.M. on 1st day, $t_2=10$ P.M., and $t_3 = 7$ A.M. next day.

When values for average or equivalent sound levels during the daytime and nighttime hours (L_d and L_n, respectively) are known, L_{dn} can be expressed as:

$$L_{dn}=10 \log_{10} \frac{1}{24} \cdot \left[15 \times 10^{L_d/10} + 9 \times 10^{(L_n+10)/10} \right]$$

where, L_d is the L_{eq} for the period 7 A.M. to 10 P.M., and L_n is the L_{eq} for the period 10 P.M. to 7 A.M.

In the assessment of rail yard noise impact, the L_{eq} and L_{dn} scales are used to indicate the response of people exposed to various levels of noise. Appendix V has been prepared to show the relationship between L_{eq} and L_{dn}. Annoyance response may vary depending upon previous exposure, age, socioeconomic status, political cohesiveness, and other social variables. However, in the aggregate for residential locations, the average degree of the expressed annoyance of groups of people increases as the cumulative noise exposure, as expressed by a rating scale such as L_{dn} increases. For example, the different forms of response to noise, such as hearing damage, speech disruption or other activity interference, and annoyance, were realted to L_{eq} or L_{dn} in the EPA Levels Document[1]. For the purposes of this study, criteria based on L_{dn} presented in the EPA Levels Document are used. Furthermore, it is assumed that if the outdoor level of $L_{dn}=55$ dB (which is identified in the EPA Levels Document as requisite to protect the public health and welfare) is met, no adverse impact in terms of general annoyance and community response exists.

The community reaction data presented in Appendix D of the Levels Document show that the expected reaction to an identifiable source of intruding noise changes from "none" to "vigorous" when the day-night average sound level increases from 5 dB below the level existing without the presence of the intruding noise to 19.5 dB above the level before intrusion. Thus, 20 dB is a reasonable value to associate with a change from 0 to 100 percent impact. Such a change in level would increase the percentage of the population that is highly annoyed by 40 percent of the total exposed population. Further, the data in the Levels Document suggest that within these upper and lower bounds the relationship between impact and level varies linearly, i.e., a 5 dB excess (L_{dn}=60 dB) constitutes a 25 percent impact, and a 10 dB excess (L_{dn}=65 dB) constitutes a 50 percent impact.

For convenience of calculation, percentages of impact may be expressed as Fractional Impact (FI). An FI of 1.0 represents an impact of 100 percent, in accordance with the following formula:

$$FI = \begin{cases} .05(L-C) & \text{for } L > C, \\ 0 & \text{for } L < C. \end{cases}$$

L is the observed or measured L_{dn} of the environmental noise, and in this study the criterion level C is L_{dn}=55 dB.

Thus, relative to projected community annoyance response, the impact of rail yard noise is expressed in terms of both extensiveness (i.e., the number of people impacted) and intensiveness (the severity of impact) by multiplying the FI value by the number of people (P) exposed for the corresponding noise level and area under consideration.

In a particular area, then, the equivalent noise impact (ENI_i), or the number of people who are considered 100 percent impacted, is given by:

$$ENI_i = FI_i \cdot P_i$$

Thus, for example, in a populated area where 1000 people are exposed to an L_{dn} (averaged over the area) of 60 dB, or an FI = 0.25, the noise impact is considered equal to 250 people 100 percent impacted. Since L_{dn} from a given source varies with distance, the FI value will vary with distance also, and the total equivalent impact is obtained by integration of the summation of the ENI_i values in the successive increments of area out from the source. In the general form, the total equivalent number of people impacted (100 percent) is:

$$ENI = \sum_i P_i \cdot FI_i$$

Summary of Analysis

A rail yard noise generation and propagation model was developed to assess the health and welfare impact due to noise from the rail yards. The impact assessment used the L_{dn} noise rating scale and the ENI rating procedure based on community annoyance response. The model included noise generation and propagation equations for each major rail yard noise source identified. Rail yard configurations and activity parameters were investigated to determine the distribution of noise sources, and the noise event occurrence rates and durations within the rail yards. Baseline L_{dn} values, noise source to boundary distances, and characteristic source lengths, where required, were determined for each source, and the computer model was used to estimate the total population exposed to rail yard noise, the equivalent number of people impacted, and the land area exposed to rail yard noise above the criterion level. In addition, the reductions in noise impact achieved assuming four alternative study levels at the yard boundaries(as discussed in Section 5) were determined. A summary of the results is shown in Table 6-1.

TABLE 6-1

RAIL YARD NOISE IMPACT

Max. Composite L_{dn} at Rail Yard Boundary* (dB)	Equivalent Number of People Impacted ENI	Population Exposed**
Baseline -------- 87	1,161,400	3,946,500
Study Level 1 --- 75	1,078,700	3,754,900
Study Level 2 --- 70	880,700	3,260,900
Study Level 3 --- 65	409,800	2,010,700
Study Level 4 --- 60	81,100	694,400

* The alternative study levels are discussed in Section 5.

** The population enclosed by the L_{dn}=55 dB contours at all the rail yards.

The basic assumptions used for the ENI analysis were:

- The noise impact rating is based on community annoyance (adverse response),
- Only rail yard noise is considered.
- There was no significant overlap in noise exposure patterns from the major groups of noise sources that are generally widely separated in the rail yards.

DISTRIBUTION AND CONFIGURATION OF RAIL YARDS

Function, Activity Rates, and Distribution

The results of the identification and classification of railroad equipment and facilities in Section 3 indicated that railroad yards can basically be categorized into two types:[5]

- Hump Yards
- Flat Yards,

and four functions:

- Classification (C) Yards
- Classification/Industrial (C/I) Yards
- Industrial (I) Yards
- Small Industrial (SI) Yards.

In developing the rail yard noise impact model,it was considered appropriate to group all hump yard complexes,(which include C, C/I, and I yards) into one category, which was referred to generally as hump classification yards, and to group all flat classification and classification/industrial yards into one general category of flat classification yards. The flat industrial yards and the flat small industrial yards were grouped as separate categories. Thus, the four basic rail yard categories used in the impact model are:

- Hump Classification Yards
- Flat Classification Yards
- Flat Industrial Yards
- Flat Small Industrial Yards.

In the rail yard study document, the rail yard types and locations were also grouped by the average level of activity (traffic rate), the population size of the urban area in which the yard is located, and by the general land use designation adjacent to the yard.[5] There were six population size classes used based on the "greater urban area" definition in the 1970 census documents. <5000, 5000 to 50,000, 50,000 to 100,000, 100,000 to 250,000, 250,000 to 500,000, and >500,000 people. The hump and flat classification yards were also grouped into low, medium, or high average-traffic rate (activity level) classes. The average magnitudes of the activity level descriptors for hump and flat classification yards are shown in Tables 6-2 and 6-3, respectively.

The number of yards in each type and place-size category were also distributed according to five general land use designations: agricultural, commercial, industrial, residential, and undeveloped.[5] The designation of rail yard locations by type of land use was determined from a questionaire/survey conducted during the SRI rail yard study, and was a result of subjective judgements by Federal Railroad Administration (FRA) Safety Inspectors. The judgements made apparently were that the land use surrounding each yard was characterized by industrial, residential, or other use. However, it is considered likely that in each case the surrounding land use was a mixture of several different types, and that in the case of industrial and commercial land uses, there were adjacent residential areas.

The numerical distribution of rail yard types by fraction, location (place size), activity rate, and adjacent land use are shown in Section 3, Tables 3-10 through 3-14.

A summary of the yard data discussed in Section 3 is shown in Table 6-4 in terms of number of yards by type of yard, place size of yard location, and rate of traffic (activity). The distribution of yards by the six place size in Tables 3-11 and 3-12 was changed to the distribution of yards in the 3 place sizes shown in Table 6-4.

TABLE 6-2

ACTIVITY RATES FOR HUMP CLASSIFICATION YARDS[5]

Activity Parameter	Traffic Rate Category		
	Low (<1000)*	Medium (1000 to 2000)*	High (>2000)*
No. of Classification Tracks	26	43	57
Receiving Tracks	11	11	13
Departure Tracks	9	12	14
Standing Capacity of Classification Yard	1447	1519	2443
Standing Capicity of Receiving Yard	977	1111	1545
Standing Capacity of Departure Yard	862	969	1594
Cars Classified Per Day	689	1468	2386
Local Cars Dispatched Per Day	86	250	315
Industrial Cars Dispatched Per Day	74	86	220
Road-Haul Cars Dispatched Per Day	632	1050	2297
Cars Reclassified Per Day	94	195	275
Cars Weighed Per Day	74	42	149
Cars Repaired Per Day	38	43	153
Trailers & Containers Loaded or Unloaded Per Day	36	30	39
Average Time In Yard (Hours)	21	22	22
Inbound Road-Haul Trains Per Day	8	14	27
Outbound Road-Haul Trains Per Day	8	14	25
Local Trains Dispatched Per Day	2	3	5
Hump Engine Work Shifts Per Day	3	5	6
Makeup Engine Work Shifts Per Day	3	6	11
Industrial Engine Work Shifts Per Day	2	2	10
Roustabout Engine Work Shifts Per Day	2	1	4

*Range of number of rail cars classified per day

TABLE 6-3

ACTIVITY RATES FOR FLAT CLASSIFICATION YARDS[5]

Activity Parameter	Traffic Rate Category		
	Low (<500)*	Medium (500 to 1000)*	High (>1000)*
No. of Classification Tracks	14	20	25
Standing Capacity of Classification Yard	643	983	1185
Cars Classified Per Day	288	711	1344
Local Cars Dispatched Per Day	72	93	182
Industrial Cars Dispatched Per Day	47	69	121
Road-Haul Cars Dispatched Per Day	218	472	942
Cars Reclassified Per Day	60	196	348
Cars Weighed Per Day	14	21	16
Cars Repaired Per Day	13	28	31
Trailers & Containers Loaded or Unloaded Per Day	22	22	76
Average Time In Yard (Hours)	19	19	18
Inbound Road-Haul Trains Per Day	3	6	10
Outbound Road-Haul Trains Per Day	3	7	11
Local Trains Dispatched Per Day	2	3	2
Industrial Engine Work Shifts Per Day	2	3	4
Roustabout Engine Work Shifts Per Day	0	1	2
Switch Engine Work Shifts Per Day	4	7	10

*Range of number of rail cars classified per day

TABLE 6-4

RAIL YARD DISTRIBUTION BY YARD TYPE, PLACE SIZE AND TRAFFIC RATE CATEGORY

NUMBER OF RAIL YARDS

Place Size (Population)

Yard Type	Less Than 50 Traffic Rate: Low	Med	High	50 to 250 Traffic Rate: Low	Med	High	Greater Than 250 Traffic Rate: Low	Med	High	Total
I Hump Classification	19	19	14	14	12	8	13	16	9	124
II Flat Classification	321	204	104	135	83	44	115	70	37	1113
III Industrial	849			239			293			1381
IV Small Industrial	1262			133			156			1551
Total	2792			668			709			4169

Configuration Analyses

1. Introduction

Preliminary analyses indicated that the configuration of rail yard facilities was very complex, and thus, accurate analyses of rail yard noise impact and noise reduction costs required determination of typical or representative dimensions for yard geometries and noise source locations relative to yard boundaries and adjacent residential areas. The available maps, which consisted mainly of U.S.G.S. 7 1/2 minute Quadrangle maps, did not provide sufficient detail to detect yard boundaries and noise source locations. This type of information was essential to developing the input parameters (source to boundary distances, land use distributions, etc.) for the noise propagation models, the health and welfare impact model, and the noise reduction cost model. Therefore, the assistance of the EPA's Environmental Photographic Interpretation Center (EPIC) was enlisted to provide additional data through examination of aerial (photographic) imagery of rail yard complexes.

The objective of the photographic evaluation was to acquire sufficient data (yard boundary dimensions, etc.) to develop within acceptable statistical certainty limits representative configurations for each type of yard.

The data requested from EPIC included:

- Percentage distribution of land uses (agricultural, commercial, industrial, residential, and undeveloped) along the rail yard boundaries, and within a one-half mile wide strip along both sides of the rail yards.

- Boundary to boundary and track to track widths of the receiving, departure, and rail car classification areas of rail yard complexes

- Lengths of receiving, departure, and classification areas.

- Distances from rail yard boundaries to the nearest cluster of residences, measured from several locations around the yards.

- Distances to yard boundaries on each side from master retarders, repair facilities, road-haul locomotives, and switch engines.

In general, the selection of the rail yard sample from which the representative yard data were obtained was conducted by a random process to avoid inadverdent biasing of the desired input parameters for the health and welfare impact model. As indicated in Table 6-4, there are 4169 rail yards in the U.S. to consider, and these consist of 4 types of yards located according to 3 population size classes. Due to schedule and resource constraints, a decision was made to obtain via a random selection process, ten yards for each of the twelve yard type-lace size combinations (i.e., cells), for a total of 120 representative yards.

2.0 Selection Procedure

In order to obtain the 120 rail yards necessary to develop representative site-specific data, 300 yards were initially chosen from the SRI[1] list of 4169 rail yards in the U.S. This list has about 80 pages with nearly 50 yards listed on each page, and it is arranged alphabetically by state, city, yard name and railroad company. Thus, as far as yard type and place size are concerned, the listing is random. The procedure for selecting the 300 yards was designed to evenly distribute, as much as possible, the yard sampling throughout the list, and consequently, throughout the U.S. Roughly, every fourteenth or fifteenth yard on the list was selected for inclusion in the sampling, until a total of 300 yards had been chosen.

These 300 yards were then classified into the twelve cells, representing combinations of the three place size and four yard type categories. As shown in Table 6-5, the resulting distribution of yards among the cells was very uneven. It would have been ideal to classify all the yards on the SRI list into the twelve cells, and then randomly pick the requisite ten yards from each cell, but because of lack of time and resources, a more practical approach was taken and additional yards were selected from the list to augment the deficient cells.

The procedure for selecting the initial 300 yards was modified somewhat to select the additional yards because it was felt that it would be too time consuming to use, given the relatively small overall percentage of some yard types. (e.g., hump yards). To assure that these additional yards were uniformly distributed throughout the list, a selection formula was developed for each cell, based upon the number of additional yards required for that cell. For example, cell number 3 needed several additional yards, so the total number of pages in the list (80) was divided by number of yard required (7), which equals eleven; thus, every eleventh page was examined for the required yard type (in this case, hump classification yards in areas with more than 250,000 people) until the requisite number of additional yards had been obtained. In some cases, it was necessary to go through the list several times, starting with a different page number but following the same page-interval formula, in order to find the needed yards.

When all twelve cells had at least ten yards in them, a similar random selection procedure was followed to select ten yards from those cells that had a surplus of yards in them. Table R-1 in Appendix R presents the initial list of 120 rail yards, by cell number which was developed using the procedures described above. However, as discussed in Appendix R, substitutions were required for some yards, and the final list is given in Table 6-6.

When this list of 120 rail yards was given to EPIC for extraction of yard data from aerial imagery, EPIC indicated that 25 of the yards would require substitutes, because nine of the yards had been abandoned, thirteen had inadequate photo coverage, and three for various other reasons. Each cell needed at least one substitute yard, and so basically the same selection procedure was used as was developed for filling the previously described deficient cells. The only difference was, in the

TABLE 6-5

DISTRIBUTION OF RAIL YARDS SELECTED FOR PHOTOGRAPHIC EVALUATION BY PLACE SIZE AND YARD TYPE

		Place Size		
		1	2	3
Yard Type		<50k People	50k-250k People	>250k People
I.	Hump Class	Cell #1 6	Cell #2 0	Cell #3 3
II.	Flat Class	Cell #4 42	Cell #5 12	Cell #6 20
III.	Flat Ind.	Cell #7 55	Cell #8 5	Cell #9 27
IV.	Small Ind.	Cell #10 85	Cell #11 10	Cell #12 14

TABLE 6-6
RAIL YARDS INCLUDED IN EPIC SURVEY

STATE	CITY	YARD	RAIL ROAD	FUNCTION	YARD TYPE
AL	Ensley	Ensley	SOU	Industrial	Flat
AZ	Tucson	Train	SP	Class./Indus.	Flat
AR	Fort Smsith	Train	MP	Small Indus.	Flat
AR	Little Rock	E. 6th Street	MP	Small Indus.	Flat
AR	N. Little Rock	Crest	MP	Class./Indus.	Hump
AR	Pine Bluff	Gravity	SSW	Class./Indus.	Hump
CA	Bloomington	W. Colton	SP	Class./Indus.	Hump
CA	E. Pleasanton	Train	SP	Industrial	Flat
CA	Martell	Train	AMC	Small Indus.	Flat
CA	San Jose	College	SP	Industrial	Flat
CA	Stockton	Mormon	ATSF	Class./Indus.	Flat
CO	Pueblo	Train	ATSF	Class./Indus.	Hump
CA	Stamford	Stamford	PC	Industrial	Flat
FL	Nichols	Dry Rock	SCL	Industrial	Flat
FL	Pensacola	Wharf	LN	Industrial	Flat
FL	Tampa	Rockport	SCL	Class./Indus.	Hump
FL	W. Palm Beach	W. Palm Beach	WPBT	Industrial	Flat
GA	Atlanta	Howell	SCL	Class./Indus.	Flat
GA	Brunswick	Brunswick	SCL	Industrial	Flat
GA	Columbus	Columbus	SCL	Industrial	Flat
GA	Macon	Old CG	CGA	Small Indus.	Flat
GA	Macon	Brosnan	SOU	Class./Indus.	Hump
GA	Savannah	Paper Mill	CGA	Small Indus.	Flat
GA	Vidalia	Vidalia	SCL	Small Indus.	Flat
IL	Chicago	Corwith	ATSF	Class./Indus.	Hump
IL	Chicago	Western Ave.	CMSPP	Small Indus.	Flat
IL	Chicago	43rd Street	CRIP	Industrial	Flat
IL	Chicago	58th Street	PC	Class./Indus.	Hump
IL	Chicago Heights	Heightsd	BO	Industrial	Flat
IL	E. St. Louis	Madison	TRRA	Class./Indus.	Hump
IL	Flora	Train	BO	Classification	Flat
IL	Joliet	South Joliet	ICS	Small Indus.	Flat
IL	Markham	Markham SBND	ICG	Classification	Hump
IL	Streator	Train	PC	Class./Indus.	Flat
IN	Burns Harbor	Burns Harbor	PC	Industrial	Flat
IN	Elkhard	RBIP Young Hump	PC	Class./Indus.	Hump
IN	Evansville	Harwood	ICG	Class./Indus.	Flat
IN	Jasonville	Latta	CMSPP	Class./Indus.	Flat
IN	Terre Haute	Hulman	CMSPP	Industrial	Flat
IA	Des Moines	Bell Avenue	CNW	Class./Indus.	Flat
IA	Missouri Valley	Train	CNW	Class./Indus.	Flat
KS	Durand	Train	MP	Small Indus.	Flat
KY	Owensboro	Doyle	ICG	Small Indus.	Flat
KY	Russell	Coal Class	CO	Industrial	Hump
KY	Silver Grove	Stevens	CCO	Class./Indus.	Hump
LA	New Orleans	Harahan	ICG	Small Indus.	Flat
LA	New Orleans	Oliver St.	SOU	Class./Indus.	Flat
LA	Shreveport	Deramus	KCS	Class./Indus.	Flat
ME	South Portland	Rigby	PTM	Class./Indus.	Flat

TABLE 6-6 (Continued)

MD	Owings Mills	Maryland	WM	Small Indus.	Flat
MA	Boston	Yard 8	BM	Industrial	Flat
MA	Lowell	Bleachery	BM	Class./Indus.	Flat
MA	Worcester	Worcester	BM	Class./Indus.	Flat
MI	Ann Arbor	Ann Arbor	AA	Industrial	Flat
MI	Detroit	Davison Ave.	DT	Class./Indus.	Flat
MI	Detroit	Flat Rock	DTI	Class./Indus.	Hump
MI	Willow Run	Industrial	PC	Class./Indus.	Flat
MN	Duluth	Missabi Jct.	DMIR	Small Indus.	Flat
MN	Inver Grove	Train	CRIP	Class./Indus.	Flat
MN	St. Paul	New	CMSPP	Class./Indus.	Hump
MN	Sleepy Eye	Train	CNW	Small Indus.	Flat
MS	Durant	Durant	ICG	Industrial	Flat
MO	St. Louis	12th Street	MP	Class/Indus.	Flat
MT	Billings	Stock	BN	Small Indus.	Flat
MT	Helena	Train	BN	Class./Indus.	Flat
NE	Lincoln	E. B. Hump	BN	Class./Indus.	Hump
NE	Lincoln	Train	OLB	Industrial	Flat
NE	McCook	Train	BN	Industrial	Flat
NE	Omaha	Freight House	UP	Small Indus.	Flat
NJ	Camden	Pavonia	PC	Class./Indus.	Hump
NY	Binghamton	YD	DH	Class./Indus.	Flat
NY	Buffalo	Hamburg St.	EL	Industrial	Flat
NY	Mechanicville	Hump	BM	Classification	Hump
NY	Olean	Train	EL	Small Indus.	Flat
NY	Syracuse	Dewitt	PC	Classification	Hump
NY	Troy	Troy	PC	Industrial	Flat
OH	Akron	Mill St.	EL	Industrial	Flat
OH	Cincinnati	Fairmont	BO	Small Indus.	Flat
OH	Dayton	Needmore	BO	Class./Indus.	Flat
OH	Hamilton	Wood	HO	Industrial	Flat
OH	Huron	South	NW	Class./Indus.	Flat
OH	Lancaster	Lancaster	CO	Class./Indus.	Flat
OH	Lorain	South	LT	Class./Indus.	Flat
OH	Marion	Westbound	EL	Class./Indus.	Hump
OH	Portsmouth	W.B. Hump	NW	Class./Indus.	Hump
OH	Springfield	Int'l Harv.	PC	Industrial	Flat
OH	Toledo	Lang	DTS	Class./Indus.	Hump
OK	Madill	Train	SLSF	Small Indus.	Flat
OK	Tulsa	Lafeber	MIDLV	Industrial	Flat
OK	Eugene	Train	SP	Class./Indus.	Hump
OR	Portland	Lake	PRTC	Class./Indus.	Flat
OR	Salem	Train	BN	Industrial	Flat
PA	Allentown	Allentown E.	LV	Class./Indus.	Hump
PA	Cementon	Cementon	LV	Small Indus.	Flat
Pa	Harrisburg	Enola West	PC	Class./Indus.	Hump
PA	Philadelphia	Midvale	PC	Industrial	Flat
PA	Pittsburgh	Neville Isl.	POV	Industrial	Flat
PA	Pittsburgh	Monon Jct.	URR	Class./Indus.	Hump
PA	Sayre	Sayre	LV	Class./Indus.	Flat
SC	Greenville	South	SOU	Small Indus.	Flat
SC	Hampton	Train	SCL	Small Indus.	Flat

TABLE 6-6 (Continued)

TN	Chattanooga	De Butts	SOU	Class./Indus.	Hump
TN	Knoxville	John Sevier	SOU	Class./Indus.	Hump
TN	Memphis	Hollywood	ICG	Class./Indus.	Flat
TX	Abilene	Abilene	TP	Industrial	Flat
TX	Austin	Train	MP	Small Indus.	Flat
TX	Cleburne	Cleburne	ATSF	Class./Indus.	Flat
TX	Fort Worth	Birds	ATSF	Small Indus.	Flat
TX	Great S.W.	Great S.W.	GSW	Industrial	Flat
TX	Houston	Bellaire	SP	Small Indus.	Flat
TX	Houston	Dollarup	HBT	Small Indus.	Flat
TX	Lubbock	Lubbock	ATSF	Class./Indus.	Flat
TX	Port Arthur	Train	SP	Class./Indus.	Flat
UT	Salt Lake City	Fourth South	DRGW	Small Indus.	Flat
VA	Crewe	Train	NQ	Classification	Flat
VA	Richmond	Belle Isle	SOU	Industrial	Flat
VA	Roanoke	Roanoke	NW	Class./Indus.	Hump
WA	Gold Bar	Train	BN	Small Indus.	Flat
WA	Seattle	House	UP	Small Indus.	Flat
WI	Milwaukee	Airline	CMSPP	Classification	Hump

case of the cells which had excess yards initially, the substitute yards were chosen from the initial surplus yards (e.g., Cell number 7). At least two additional yards were selected for each cell, and the substitute yard list was prioritized so that the yards at the top of each cell's substitute list were from the same general part of the SRI list as the original yards which they were replacing. Table R-2, Appendix R, presents the substitute yard list by cell number.

Using the initial list of 120 rail yards, EPIC located each yard on U.S. Geological Survey (U.S.G.S.) quadrangle maps, samples of which are shown in Appendix R, Figures R-1 and R-2. EPIC then ascertained whether there was sufficient recent aerial imagery of the yard and vicinity to gather the necessary data.. As previously mentioned, there were 25 yards which either had been abandoned or for which there was inadequate photo imagery available. In these cases, another yard was selected from the appropriate cell on the substitution yard list.

Bausch and Lomb zoom scopes and light table for viewing transparencies (transparent aerial imagery) of the yard areas were used for photo analyses and to produce overlays (see Appendix R, Figures R-3 and R-4) on the U.S.G.S. quandrangle maps, indicating yard boundaries, and land use areas within 2000 feet of the boundaries. Based on the Standard Land Use Coding System (re. U.S. DOT-FHWA 1969), the land uses around each yard were grouped into the following types: residential, commercial, industrial, agricultural, and undeveloped. In addition to determining yard boundaries and land use areas, EPIC extracted the following yard data from the aerial imagery using a scaled eye loop on tube magnifier in some cases: distance from boundaries to residential areas; yard dimensions; and location of identifiable noise sources within the yard. These sources included repair facilities, retarders, switch engines, road engines, TOFC/COFC, and bulk loading facilities. Figure R-5 and R-6 illustrate the data sheets used, with data from two sample yards.

3.0 Data Evaluation

a. Procedure for Grouping and Averaging the Sample Rail Yard Data:

The random selection of rail yards in the hump and flat classification types was conducted independently of considerations regarding the activity parameters of the yards since the traffic rate category of any particular yard was unknown. However, the detail of analyses necessary for the health and welfare and cost impact models required determination of typical rail yard dimensions for the low, medium, and high activity or traffic rate categories. Therefore, it was necessary to estimate from the sample yard dimensions into which category each rail yard could be placed.

The FRA/SRI rail yard study data was used to estimate the classification yard area corresponding to the average traffic rates determined for the low, medium, and high activity categories. This was done by using the average rail car length (69 ft.) and distance between parallel classification trucks (15 ft.) in conjunction with the number of cars classified per day and the number of classification trucks given by the SRI study for a yard type and traffic category to compute the equivalent length and width, and then the typical area covered by the classification tracks. Thus--

$$\text{Equivalent length (1)-2*x } \frac{\text{rail cars/day x length/car}}{\text{number of parallel tracks}}$$

Equivalent width (w) = number of tracks x distance between tracks.

Typical area covered (A) = w x 1.

*The factor of 2 accounts for the switching areas at end of the classified rail car storage area.

The range of typical areas for the average traffic rates for low, medium, and high activity traffic rates for low, medium, and hig activity hump and flat classification yards was also computed in the same manner. This provided 3 ranges (or bandwidths) of areas bracketing the low, medium, and high traffic rate yard sizes.

The classification portion dimensions for each of the sample hump and flat classification yards analyzed by EPIC were used to obtain the corresponding classification yard areas. These areas were compared to the previously determined area ranges and thus each yard was placed in one of the traffic rate categories. In this way, the traffic rate categories for 26 of the 30 sample hump yards (in cells 1, 2, and 3) were estimated (in the remaining 4 cases the yard dimensions were ambiguous). As a result, 9 of the yards were placed in the low activity category, 9 in medium, and 8 in high. The sample flat classification yards were distributed into the 3 traffic rate categories as follows: 12 low, 8 medium, and 3 high (for 7 of the 30 sample yards, the dimensions were ambiguous).

The purpose of classifying the sample hump and flat classification yards into low, medium, and high activity rates was to provide groups of sample yards for which the dimensions could be tabulated and averaged to derive representative yard configurations of each type. This was done irrespective of the place size class for each sample yard location since there was no indication that yard dimensions were correlated with place size (or location). For example, the representative dimensions for low traffic rate hump classification rail yards were obtained by averaging the dimensions from 3 sample hump yards located in the small place class, 3 in the medium place size class, and 3 in the large place size class.

b. Data Used for Determining Average Dimensions:

The data requested from the EPIC survey of the selected rail yards included:

- Track-to-track width, boundary-to-boundary width, and length of the classification and receiving and departure portions of the rail yard complexes.

- Distances to the boundaries on both sides of the rail yards from the master retarder and engine repair areas, and from observed road haul locomotives and switch engines.

- Distances from the rail yard boundaries to the nearest cluster of residential buildings at several locations around the rail yard.

Examination of the data for the flat and hump classification yards indicated that, in general, the yards were asymmetrical and quite complicated in configuration. Time constraints and data limitations required that the yard data be reduced to obtain simplified representative yard configurations. Therefore, it was assumed that the various portions of the rail yards were rectangular and that groups of noise sources were located within the rectangular areas at unequal distances from the yard boundaries. In addition, the yard configuration and noise source location analyses indicated that the master retarder, engine repair, and idling road haul locomotive locations were in the same general area. Therefore, the dimensions obtained from the EPIC analyses were grouped into distances from the sources (or assumed source group locations) to the nearest and farthest yard boundaries. In the case of the observed locomotives, at any yard, the weighted average distances of the boundaries were obtained by multiplying the number of locomotives by the corresponding distances, summing the products, and then dividing by the number of locomotives observed. Thus, the measured dimensions for each group of yards (low, medium, and high traffic activity groups determined as discussed in the preceding sub-section) were tabulated and then averaged. The resulting average dimensions are shown in Tables 6-7 through 6-9.

TABLE 6-7

SUMMARY OF AVERAGE DIMENSIONS FOR HUMP CLASSIFICATION YARDS

Average Dimensions (ft.)
Traffic Rate:

Hump Yards	Low		Medium		High	
	Near**	Far**	Near	Far	Near	Far
Classification Area:						
D^*_w	205	632	277	558	352	690
D_{MR}	198	770	328	626	368	735
D_{ER}	222	422	295	736	370	980
D_{RL}	225	579	326	702	379	615
D_{AVG}	210	600	310	660	370	750
L	3700		4300		5700	
Receiving and Departure Area:						
$D_{avg}=D^*w$	150	450	130	480	180	560
L	5100		6400		6400	

*D_w Near = Track to track width ÷ 2
D_w Far = Boundary to boundary width ÷ 2
D_{MR} = Distance from master retarder to yard boundary
D_{ER} = Distance from engine repair area to yard boundary
D_{RL} = Weighted average distance from road haul locomotives to yard boundary
**Shorter and larger distances from source to boundaries.

TABLE 6-8

SUMMARY OF AVERAGE DIMENSIONS FOR FLAT CLASSIFICATION YARDS

Flat Classification Yards	Average Dimensions (ft.) Traffic Rate: Low		Medium		High	
	Near**	Far**	Near	Far	Near	Far
Classification Area:						
D^*_W	80	240	130	-	230	600
D_{ER}	130	340	-	-	-	520
D_{RL}	***	-	80	380	390	-
D_{SE}	150	470	-	460	340	960
D_{AVG}	120	350	105	420	300	700
L	2800		4300		6800	
Receiving and Departure Area:						
$D_{avg}=D^*_W$	100	350	100	450	300	600
L	2600		3200		4100	

*D_W Near = Track to track width ÷ 2
D_W Far = Boundary to boundary width ÷ 2
D_{ER} = Distance from engine repair area to yard boundary
D_{RL} = Weighted average distance from road haul locomotives to yard boundary
D_{SE} = Weighted average distance from switch engines to yard boundary.
**Shorter and larger distances from source to boundaries.
***Blank space indicates uncertainties in data. Averages judged not applicable.

TABLE 6-9

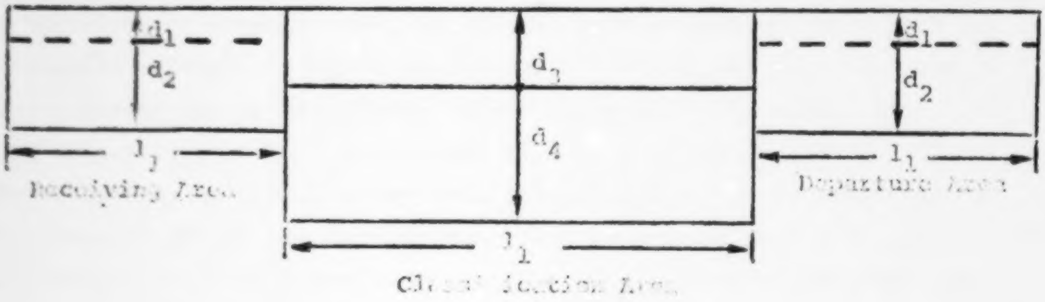
REPRESENTATIVE AVERAGE DIMENSIONS FOR INDUSTRIAL AND SMALL INDUSTRIAL RAIL YARDS

	Average Dimensions (ft.)	
	Industrial Yards	Small Industrial Yards
D_W	230	170
D_{RL}	190	80
D_S	200	100
D_{AVG}	230	170
L	4300	3300

Also, the hump yard classification area widths were averaged with the master retarder, engine repair facility, and road haul locomotive distances to obtain the representative average distances (D_{AVG}) to the near and far boundaries. In the case of the flat classification yards, the classification area widths were averaged with the source to boundary distances for the observed engine repair facilities, road locomotives, and switch engines. The observed engine repair facilities and road haul locomotives were assumed to indicate that the positions of the load test facilities and storage of idling locomotives (identified noise sources for the noise impact model) were at the master retarder end of the classification area. In the case of flat classification yards, the locations of the switch engines observed by EPIC were not specified, however, they were assumed to be located at each end of the classification area, and thus, tended to also indicate the dimensions of the classification area. Similar analyses of the data from the sample industrial and small industrial yards resulted in the representative dimensions shown in Table 6-9. The configurations of the industrial and small industrial yards were generally more symetrical than the other yards, and thus, the representative dimensions indicate that sources are located in the center of the yard areas (equi-distant from the boundaries on either side).

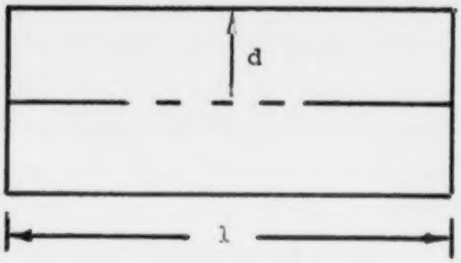
Representative Rail Yard Configurations

The representative configurations derived from the EPIC rail yard data evaluation are shown in Figures 6-1 and 6-2. The hump and flat classification yards were assumed to have identical receiving and departure area dimensions (the receiving and departure areas could usually not be differentiated on the photographic imagery). The d_1 distance of 140 ft. for the low and medium traffic rate hump yards is the average of the corresponding distances of 130 and 150 ft. previously determined. Also, the d_4 distance of 630 ft. for the low and medium traffic rate is the average of the corresponding for distances of 600 and 660 ft. previously determined. Similar averaging was done to obtain the d_3 distance of 110 ft. for the low and medium traffic rate flat classification yards.



Yard Type	Representative Rail Yard Dimension (ft.)					
I. Hump Classification:	d_1	d_2	d_3	d_4	l_1	l_2
Traffic Rate:						
Low	140	420	210	630	5100	3700
Medium	140	480	310	630	6400	4300
High	180	560	370	750	6400	5700
II. Flat Classification:						
Traffic Rate:						
Low	100	350	110	350	2600	2800
Medium	100	450	110	420	3200	4300
High	300	600	300	700	4100	6800

Figure 6-1. Representative Configuration For Hump And Flat Classification Railyards



Yard Type	Representative Dimensions (ft.)	
	d	l
Industrial	230	4300
Small Industrial	170	3300

Figure 6-2. Representative Configuration For Flat Industrial And Small Industrial Railyards

Population Density Analyses

1. Local Average Population Densities for Sample Rail yards

In conjunction with the rail yard configuration analyses, computerized census data was accessed to obtain site specific population data for each of the 120 rail yards selected for examination. The objective was to obtain local average population densities in the areas adjacent to the rail yards. These data were required to accurately assess the rail yard noise impact in terms of equivalent number of people subjected to Day-Night Average Noise Levels (L_{dn}) greater than 55 dB.

The population data was generated by Consolidated Analyses Centers, Inc. (CACI) using their Site II System data base and computer program which incorporate 1970 block level census data. This program accesses and summarizes the 1970 census at the block and block group levels and also estimates the 1977 population for the selected study areas based on such information as public utility connections and residential construction rates. The CACI system produced a Demographic Profile Report for each of the 120 rail yards. Samples of these reports are shown in Appendix T, Figures T-1 and T-2.

Preliminary analyses indicated that rail yard noise could impact populations within 2000 to 5000 ft. of the yard boundaries. Therefore, for each rail yard the study area selected was rectangular in shape extending the length of the yard complex and either 2500 ft. or 5000 ft. to either side depending on the size of the yard (i.e., 5000 ft. for classification yards and 2500 ft. for industrial and small yards). In each case, the site specific or local average population density was obtained by dividing the computer estimated 1977 population (produced by the computer program) by the area within the rectangular coordinates (excluding the rail yard area). The resulting average population density values are shown in Table T-3, Appendix T.

2. Distribution of Rail Yards by Density Class

The percent of sample railyards in each density class or range was computed, and these values are shown in Table 6-10.

The average density values and percent distribution of rail yards for the corresponding density range classes were assumed to hold for (or represent) the total population of rail yards in the respective place size categories. Thus, for example, the percent distribution of rail yards in the smaller place size was assumed to hold for the yards in each yard category (type and traffic rate) in the small place size class shown in Table 6-4. Application of the percent factors in Table 6-10 to the number of yards shown for each yard type shown in Table 6-4 results in the total number of rail yards of each type estimated for each density class as shown in Tables 6-11 through 6-14.

TABLE 6-10

DISTRIBUTION OF SAMPLE RAIL YRDS BY POPULATION DENSITY RANGE

Population Density Range (People/Sq.Mi.)	Place Size less than 50,000 People	Place Size 50,000 to 250,000 People	Population Density Range (People/sq./mi)	Place Size Greater than 250,000 people
<500	8	4	<1000	6
500 to 1000	6	5	1000 to 3000	10
1000 to 2000	13	6	3000 to 5000	13
2000 to 3000	7	7	5000 to 7000	2
3000 to 5000	2	10	7000 to 10,000	2
5000 to 7000	2	4	10,000 to 15,000	3
7000 to 11,000	2	3	15,000 to 22,000	4

TABLE 6-11

DISTRIBUTION OF HUMP YARDS BY PLACE SIZE, TRAFFIC RATE CATEGORY AND POPULATION DENSITY RANGE

Place Size (Thousands of People)	Population Density Range (People/Mile^2)	Number of Yards Traffic Rate Category			
		Low	Medium	High	Total
50	<500	4	4	3	11
	500-1000	3	3	2	8
	1000-2000	6	6	4	16
	2000-3000	3	3	2	8
	3000-5000	1	1	1	3
	5000-7000	1	1	1	3
	7000-11000	1	1	1	3
	Total	19	19	14	52
50-250	<500	2	1	1	4
	500-1000	2	2	1	5
	1000-2000	2	2	1	5
	2000-3000	2	2	1	5
	3000-5000	4	3	2	9
	5000-7000	1	1	1	3
	7000-11000	1	1	1	3
		14	12	8	34
250	<1000	2	2	1	5
	1000-3000	3	4	2	9
	3000-5000	4	5	3	12
	5000-7000	1	1	1	3
	7000-10000	1	1	1	3
	10000-15000	1	1	0	2
	15000-22000	1	2	1	4
	Total	13	16	9	38
	Total				124

TABLE 6-12

DISTRIBUTION OF FLAT CLASSIFICATION YARDS
BY PLACE SIZE, TRAFFIC RATE CATEGORY
AND POPULATION DENSITY RANGE

Place Size (Population Range)	Population Density Range (People/Mile^2)	Number of Yards By Traffic Rate Category Low	Medium	High	Total
1. Less than 50,000	<500	64	41	21	126
	500-1000	48	31	16	95
	1000-2000	103	65	33	201
	2000-3000	58	37	19	114
	3000-5000	16	10	5	31
	5000-7000	16	10	5	31
	7000-11000	16	10	5	31
	Total	321	204	104	629
2. 50,000 to 250,000	<500	14	9	4	27
	500-1000	20	12	7	39
	1000-2000	20	12	7	39
	2000-3000	20	12	7	39
	3000-5000	39	24	13	76
	5000-7000	11	7	3	21
	7000-11000	11	7	3	21
	Total	135	83	44	262
3. Greater than 250,000	<1000	17	10	6	33
	1000-3000	29	18	9	56
	3000-5000	34	21	11	66
	5000-7000	9	6	3	18
	7000-10000	6	3	2	11
	10000-15000	8	5	2	15
	15000-22000	12	7	4	23
	Total	115	70	37	222
	Total				1113

TABLE 6-13

DISTRIBUTION OF INDUSTRIAL FLAT YARDS BY PLACE SIZE AND POPULATION DENSITY RANGE

Place Size (Thousands of People)	Population Density Range (People/Mile^2)	Number of Yards
50	<500	170
	500-1000	128
	1000-2000	272
	2000-3000	153
	3000-5000	42
	5000-7000	42
	7000-11000	42
		849
50-250	-500	24
	500-1000	36
	1000-2000	36
	2000-3000	36
	3000-5000	69
	5000-7000	19
	7000-11000	19
		239
250	<1000	44
	1000-3000	73
	3000-5000	88
	5000-7000	23
	7000-10000	15
	10000-15000	21
	15000-22000	29
		293
	Total	1381

TABLE 6-14

DISTRIBUTION OF SMALL INDUSTRIAL FLAT BY PLACE SIZE AND POPULATION DENSITY RANGE

Place Size (Thousands of People)	Population Density Range (People/Mile^2)	Number of Yards
50	<500	253
	500-1000	189
	1000-2000	404
	2000-3000	227
	3000-5000	63
	5000-7000	63
	7000-11000	63
	Total	1262
50-250	<500	13
	500-1000	20
	1000-2000	20
	2000-3000	20
	3000-5000	38
	5000-7000	11
	7000-11000	11
	Total	133
250	<1000	23
	1000-3000	39
	3000-5000	47
	5000-7000	12
	7000-11000	8
	11000-15000	11
	15000-22000	16
	Total	156
	Total	1551

General Description of the Noise Model

The noise sources identified in rail yards include moving and stationary sources which have varying degrees of proximity to one another depending on the yard type, function, and geometry. Some of the noise sources which contribute significantly to the overall noise environment are located or operated in specific areas of the yards while others may be randomly distributed in various sections of the yards. Even though many of the noise sources and activities can be characterized in terms of their operational parameters, such as usage time or rate of occurrence, and distribution during the daytime and nighttime periods, an accurate definition of the typical positions of source groupings relative to one another and to the rail yard boundaries is not possible without considerable additional descriptive data on the 4169 rail yards in the U.S. These data are not currently available.

Therefore, a noise generation model was developed for each identified source for which a noise data base was available. Due to the uncertainty in the noise source locations, the basic preliminary assumption made for the ENI analysis was that the noise levels on the periphery of rail yard complexes were due to widely separated individual groups of sources. Additionally, examination of the yard noise source characteristics indicated that only two types of basic noise generation models were necessary, one for stationary sources and another for moving point sources. In the case of stationary or virtual (groups of stationary) sources, the corresponding average daily noise levels are a function of source strength and percentage of time operating or number of on-off events. For the moving sources, the average daily noise levels at any observation location are a function of source strength and number of pass-by events. The noise levels resulting from the grouping of two or more individual sources were used to represent property line values and for the ENI analysis. The selection of source groupings was based on the assumed location of specific operations and activities within each rail yard type.

Another basic concept for the noise model was the grouping of rail yards by two types, hump and flat yards, and three main functions: classification, industrial, and small industrial yards. The classification yards are further separated into low, medium, and high traffic categories, based on the number of rail cars classified per day. Thus, there are eight typical yards in the composite model:

- High Traffic or Activity Hump Classification Yards
- Medium Traffic Hump Classification Yards
- Low Traffic Hump Classification Yards
- High Traffic Flat Classification Yards
- Medium Traffic Flat Classification Yards
- Low Traffic Flat Classification Yards
- Industrial Flat Yards
- Small Industrial Flat Yards

The basis for these groupings, and the supporting data on the number of yards and their distribution by location, land use, and traffic level, were developed in a railroad yard survey conducted for DOT.[5] The noise generation model is thus based on the average number of sources and activity levels for each of the classes of yards which are either presented in the referenced study or derived from the statistical data presented there.

A schematic diagram for the railroad yard noise adverse response impact model outlining the basic elements of the model and the required input information is shown in Figure 6-3.

Rail Yard Noise Sources and Levels

1. Noise Sources

The predominant noise sources for each class of rail yard were identified by examining the literature and data base on railroad equipment and facility surveys, and noise measurement studies. Discussions with the AAR staff and consultants provided additional data on potential noise

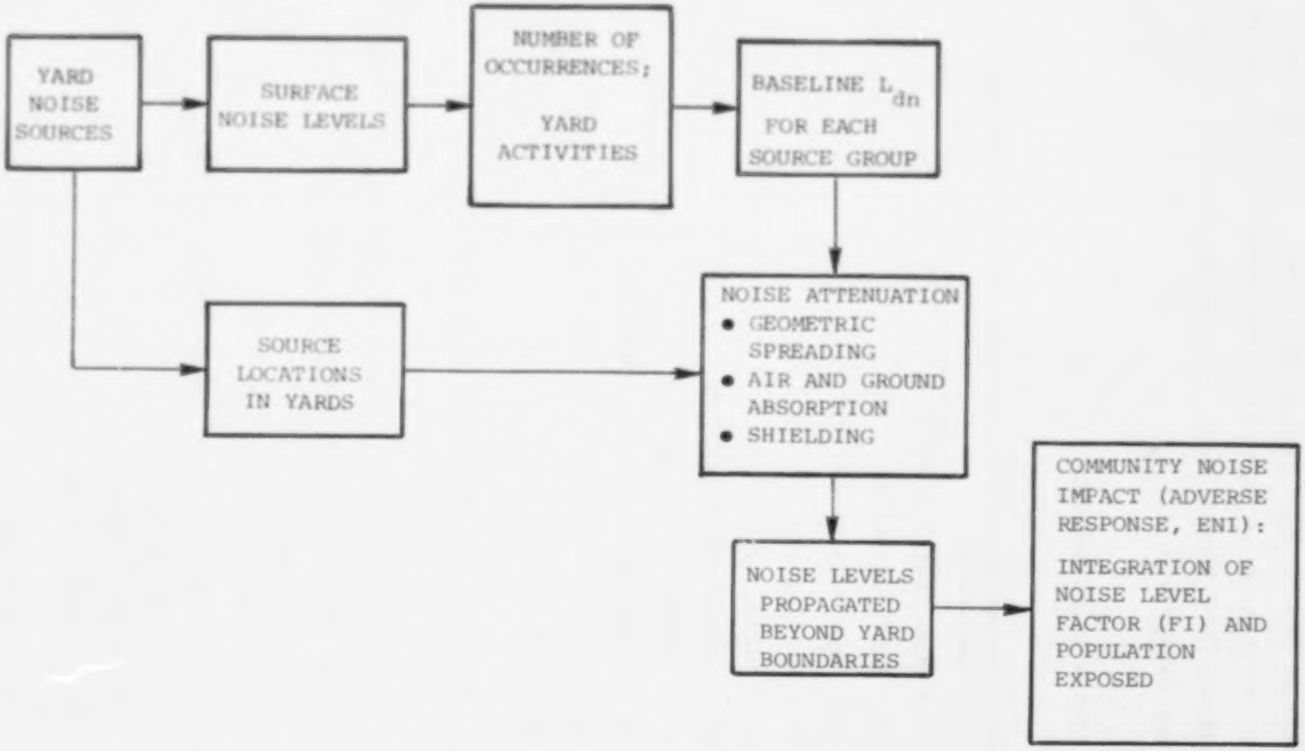

YARD NOISE SOURCES
SURFACE NOISE LEVELS
NUMBER OF OCCURRENCES; YARD ACTIVITIES
BASELINE L_{dn} FOR EACH SOURCE GROUP
SOURCE LOCATIONS IN YARDS
NOISE ATTENUATION
• GEOMETRIC SPREADING
• AIR AND GROUND ABSORPTION
• SHIELDING
NOISE LEVELS PROPAGATED BEYOND YARD BOUNDARIES
COMMUNITY NOISE IMPACT (ADVERSE RESPONSE, ENI):
INTEGRATION OF NOISE LEVEL FACTOR (FI) AND POPULATION EXPOSED

FIGURE 6-3 - RAILROAD YARD NOISE IMPACT MODEL

sources, activities, and levels. The identified noise sources for which a sufficient noise data base were available to determine a statistically meaningful average level were included in the rail yard noise model. The major noise sources which have been included in the rail yard noise model and health/welfare impact model are listed below according to yard type and function category:

- HUMP YARD - NOISE SOURCES:
  - MR - Master Retarders (Includes Group, Intermediate, and Track)
  - HS - Hump Lead Switchers
  - IR - Inert Retarders
  - MS - Makeup Switchers
  - CI - Car Impacts
  - IL - Idling Locomotives
  - LT - Locomotive Load Tests
  - RC - Refrigerator Cars
  - IS - Industrial and Other Switchers
  - OB - Outbound Trains (Road-Haul plus Local)
  - IB - Inbound Trains

- FLAT CLASSIFICATION YARD - NOISE SOURCES:
  - CSE - Classification Switchers, East End of Yard
    CSW Classification Switchers, West End of Yard,
  - CI - Car Impacts
  - IB - Inbound Trains
  - OB - Outbound Trains (Road-Haul plus Local)
  - IL - Idling Locomotives
  - LT - Load Tests
  - RC - Refrigerator Cars

- FLAT INDUSTRIAL YARD - NOISE SOURCES:
  - SE - Switch Engines
  - CI - Car Impacts
  - IB - Inbound Trains
  - OB - Outbound Trains (Road-Haul plus Local)
- SMALL INDUSTRIAL FLAT YARD - NOISE SOURCES:
  - SE - Switch Engines
  - CI - Car Impacts
  - IB - Inbound Trains
  - OB - Outbound Trains

The yard noise sources identified but not modeled include horns and whistles, locomotive brake squeal, wheel-track screech on curves, loudspeakers, slack pull-out (between cars in outbound trains or cuts of cars), compressed air release from car air brake-bleed and pneumatically-operated switches and retarder mechanisms, and other unidentified yard equipment. However, the indications from the data base are that, although the non-inclusion of these sources (which may be present in some yards, and types of yards, but not in others) results in a degree of uncertainty in the determination of the overall noise levels at rail yard boundaries, the major noise sources identified in the preceding yard noise source list produce noise levels and event rates sufficiently high to provide good indicators for the noise environment and impact at the rail yard boundaries. It should be noted that load test facilities were assumed to be located at high level activity hump and flat classification yards only. This assumption was based on survey data provided by the AAR.

Although the exact location of sources in various portions of yard complexes are unknown, there are logical source groupings and locations to consider for placement of grouped sources. Information derived from the EPIC rail yard survey, the AAR, and consultants regarding rail yard operations was used to develop reasonable source groupings and group placements within the yard complexes. For example, it was assumed that locomotive load test stations and storage of idling locomotives would be positioned in the general area of engine repair facilities.During the EPIC rail yard survey it was observed that engine repair facilities were frequently situated near the master retarder end of the classification yard. Therefore, the master retarder noise source group was assumed to include idling locomotives and load test stations. It seemed logical to form a noise source group by combining switch engine and inbound train operations (located in the receiving yard) and another group by combining other switch engine and outbound train operations (located in the departure yard).

The hump and flat classification rail yards were thus assumed to have 4 noise source groups while the flat industrial and small industrial yards were assumed to have 2 source groups. In the absence of any specific data on yardt activity parameters, it was assumed that the distances moved by switch engines and inbound and outbound locomotives are equal to the receiving and departure yard lengths of the hump and flat classification yards, and to the yard lengths of the other industrial and small industrial yard types.

2. Average Noise Source Levels

The rail yard noise data base provided average (energy basis) noise levels (L_{avg}) at a distance of 100 feet from the source for each of the major noise sources identified. In the case of time-varying noise levels (for retarder, car impact, locomotive pass-by, etc.), the averages of the maximum A-weighted sound levels, L_{avg} (max) were computed.
In addition, for moving sources (switch engines and locomotives) and intermittent sources (retarders and car impacts) an SENEL value was determined from L_{avg} values and the corresponding event duration (or time-history). The L_{avg} and SENEL values were calculated according to:

$$L_{avg} = 10 \log \frac{1}{n} \sum_{i=1}^{n} 10^{L_i/10}$$

$$\text{SENEL} = L_{avg}\,(\max) + 10 \log \pi \frac{D}{V}\ ;\ \text{moving source.}^{1/}$$

$$\text{SENEL} = L_{avg}\,(\max) + 10 \log E;\ \text{stationary source.}$$

Where:

L_i = Measured noise level for specific event i, dBA

n = Number of measurements for each source

L_{avg} = Average or average maximum noise level, dBA

D = Shortest distance between stationary observer and source path

V = Source speed

E = Effective duration, seconds.

The results are shown in Table 6-15.

The flat yard switch engine noise level represents the noise level for an acceleration condition associated with "kicking" (decoupling) cars, and pulling out a cut or block of cars. The hump switch engine noise level represents a condition of constant velocity for hump switching and other switch engine operations at a steady pull. The integration of the noise level time histories for retarder and car impact noise events given in the data base indicate average effective durations of 1/2 and 1/7 seconds, respectively.

Noise Generation Models

The noise rating scale selected to assess rail yard noise impact is the day-night average sound level, L_{dn}. Therefore, since the rail yard noise model is developed from measured sound levels for each individual source, a baseline L_{dn} value is required for each source and for each level of activity. However, the empirical data base on rail yard source noise levels in general provided average noise levels (L_{avg}) and single-event noise exposure levels (SENEL) as discussed in the previous section. It is necessary, then, to use the L_{avg} or SENEL values and the activity

TABLE 6-15

NOISE SOURCE LEVEL SUMMARY

Noise Source	Number of Measurements	Level of Energy Average* $L_{Avg.}$ @100 Ft. (dBA)	SENEL @100 Ft.
Master Retarder: Group, Track, and Intermediate	410	111	108
Inert Retarder	96	93	90
Flat Yard Switch Engine Accelerating (Throttle Set 1-2)	30	83	98 (5 MPH)
Stationary Switch Engine (Throttle Set 1-2)	4	76	-
Idling Locomotive (Throttle Set 1-2)	63	63	-
Hump Switch Engine, Constant Speed	Ref. 6	78	95 (4 MPH)
Car Impact	133	100	92
Refrigerator Car	60	63	-
Load Test (Throttle 8)	59	90	-

---

* L_{Max}.Average for Intermittent or Moving Sources

parameters, developed in the preceding section, to compute the baseline L_{dn} values. The expressions for L_{dn} will vary depending on the type of source, (moving or stationary), and mode of operation, (continuous, quasi-continuous or intermittent). Thus, the two basic general expressions for L_{dn} at a given location are:

$$L_{dn} = \text{SENEL} + 10 \log (NE_d + 10NE_n) - 49.4, \text{ and}$$
$$L_{dn} = L_{eq_H} + 10 \log (NH_d + 10NH_n) - 13.8,$$

where

NE_d = number of daytime events (or occurrences)
NE_n = number of nighttime events
L_{eq_H} = the equivalent or average sound level for 1-hour periods
NH_d = number of hours operating during the daytime
NH_n = number of hours operating during nighttime

The daytime and nighttime periods, as usual, are defined as 7 A.M. to 10 P.M., and 10 P.M. to 7 A.M., respectively. The two L_{dn} expressions above are used with the baseline noise data to compute L_{dn} values at 100 feet from the source. The latter of the two expression is applicable when L_{eq_H} remains the same for all hours the source is operated. The types of noise sources for which this condition was determined to hold are parked refrigerator cars, stationary idling locomotives, and locomotive load tests. The first expression for L_{dn} is applicable to moving sources such as the switch engines, and to intermittent sources such as car impacts and retarder noises.

A more detailed discussion of the distribution of sources in the rail yards and the methods and assumptions used to develop activity parameters (numbers of events, hours of operation, etc.) is presented in Appendix U.

RAIL YARD NOISE IMPACT

Rail Yard Boundary Noise Levels

The baseline L_{dn} values for the rail yard noise sources were determined from: 1) average source noise levels at a reference distance of 100 feet, 2) rail yard source activity and operational parameters, and 3) average attenuation factors for each noise source or group. These three parameters were used to compute rail yard boundary noise levels which formed the basic input data base for the rail yard impact model. The general expression for computing L_{dn} values will be discussed in a following section.

Analysis of the EPIC survey data indicated that, in general, hump and flat classification rail yards have an asymmetrical configuration. As a result, a near and a far yard bounndary distance was assigned to each yard source and an L_{dn} value was determined for each boundary distance. The generalized configurations and dimensions for each rail yard type are shown in Figures 6-1 and 6-2. A summary listing of the input data base L_{dn} values as a function of distance to the near and far side of the yard boundary is presented on Tables 6-16 through 6-19.

Noise Impact Analysis Method

In order to provide a quantitative assessment of rail yard noise impact, a method is required for computing the number of people exposed to outdoor noise levels corresponding to an L_{dn} greater than 55. The basis for this criterion level, and the noise rating scale selected by the EPA for impact assessment are outlined in the introduction to Section 6. The EPA Levels Document has indicated that for environmental noise levels which are between 0 and 20 dB above the identified threshold noise levels for various health and social welfare effects, the impact, in terms of the statistical average effects or number of people who complain, varies linearly with the level. Accordingly, the degree of adverse response or community annoyance has been expressed in terms of a parameter defined as fractional impact (FI). For example, at FI=1 (or L_{dn} = 75 dB) there

TABLE 6-16

HUMP YARD NOISE SOURCE CONTRIBUTION TO DAY-NIGHT SOUND LEVEL (L_{dn}) AS A FUNCTION OF DISTANCES (d_n/d_f) TO NEAR AND FAR SIDE OF YARD BOUNDARY, AND TRAFFIC RATE CATEGORY

		L_{dn} (dB) @ d_n/d_f (ft.) TRAFFIC RATE CATEGORY					
Source Group	Noise Source	LOW		MEDIUM		HIGH	
		Near Side	Far Side	Near Side	Far Side	Near Side	Far Side
(a)		@140 ft	@450 ft	@140 ft	@480 ft	@180 ft	@560 ft
	Hump Switchers	65	60	68	63	69	64
	Inbound Trains	64	58	67	61	68	62
	Composite Levels	68	62	71	65	72	66
(b)		@210 ft	@630 ft	@310 ft	@630 ft	@370 ft	@750 ft
	Retarders (Master and Group)	86	72	85	75	87	76
	Idling Locomotives	70	60	70	64	68	59
	Load Tests	--	—	--	--	75	69
	Composite Levels	86	72	85	75	87	77
(c)		@210 ft	@630 ft	@310 ft	@630 ft	@370 ft	@750 ft
	Inert Retarders	68	54	67	57	69	58
	Refrigeration Cars	66	55	69	62	69	62
	Car Impacts	71	59	70	63	70	62
	Composite Levels	74	61	73	66	74	66
(d)		@140 ft	@450 ft	@140 ft	@480 ft	@180 ft	@560 ft
	Makeup Switchers	68	62	71	65	71	65
	Industrial Switchers	69	63	68	62	72	66
	Outbound Trains	65	59	68	62	69	63
	Composite Levels	73	67	74	68	76	70

TABLE 6-17

FLAT CLASSIFICATION YARD NOISE SOURCE CONTRIBUTION TO DAY-NIGHT SOUND LEVEL ($_{dn}$) AS A FUNCTION OF DISTANCES (d_n/d_f) TO NEAR AND FAR SIDE OF YARD BOUNDARY, AND TRAFFIC RATE CATEGORY

		L_{dn} (dB)@ d_n/d_f (ft.) TRAFFIC RATE CATEGORY					
		LOW		MEDIUM		HIGH	
Source Group	Noise Source	Near Side	Far Side	Near Side	Far Side	Near Side	Far Side
(a)		@100 ft	@350 ft	@100 ft	@450 ft	@300 ft	@600 ft
	Classification Switches (W)	69	64	74	67	71	67
	Inbound Trains	60	55	63	56	60	57
	Composite Levels	70	65	74	67	71	67
(b)		@110 ft	@350 ft	@110 ft	@420 ft	@300 ft	@700 ft
	Idling Locomotives	75	65	78	67	70	63
	Load Tests	--	--	--	--	78	70
	Composite Levels	75	65	78	67	79	71
(c)		@110 ft	@350 ft	@110 ft	@420 ft	@300 ft	@700 ft
	Refrigeration Cars	75	65	77	66	71	63
	Car Impacts	73	62	77	65	70	60
	Composite Levels	77	67	80	69	74	65
(d)		@100 ft	@350 ft	@100 ft	@450 ft	@300 ft	@600 ft
	Classification Switches (E)	69	64	74	67	71	67
	Outbound Trains	64	59	67	60	63	60
	Composite Levels	70	65	75	68	72	68

TABLE 6-18

FLAT INDUSTRIAL YARD NOISE SOURCE CONTRIBUTION TO DAY-NIGHT SOUND LEVEL (L_{dn}) AS A FUNCTION OF DISTANCES (d_n/d_f) TO NEAR AND FAR SIDE OF YARD BOUNDARY

Source Group	Noise Source	L_{dn} (dB) @ d_n/d_f (ft.) Near Side	Far Side
(a)		@230 ft	@230 ft
	Inbound Trains	53	53
	Outbound Trains	53	53
	Switch Engines	69	69
	Composite Levels	69	69
(b)	Car Impacts	63	63
	Composite Levels	63	63

TABLE 6-19

SMALL FLAT INDUSTRIAL YARD NOISE SOURCE CONTRIBUTION TO DAY-NIGHT SOUND LEVEL (L_{dn}) AS A FUNCTION OF DISTANCES (d_n/d_f) TO NEAR AND FAR SIDE OF YARD BOUNDARY, AND TRAFFIC RATE CATEGORY

Source Group	Noise Source	L_{dn} (dB) @ d_n/d_f (ft.) Near Side	Far Side
(a)		@170 ft	@170 ft
	Inbound Trains	54	54
	Outbound Trains	54	54
	Switch Engines	64	64
	Composite Levels	65	65
(b)	Car Impacts	59	59
	Composite Levels	59	59

is a 100 percent impact. The FI relationship for other L_{dn} values is given by the following equation:

$$FI = \frac{1}{20}(L_{dn} - 55) \text{ for } L_{dn} > 55$$

$$FI = 0 \text{ for } L_{dn} \leq 55$$

In computing the number of people affected by rail yard noise using the fractional impact concept, the magnitude of total impact associated with a defined level of environmental noise is determined by multiplying the number of people (P) exposed by the corresponding fractional impact (FI) value for a given noise level and area:

$$ENI_i = FI_i P_i$$

ENI_i is the equivalent number of people who receive a fractional impact equal to unity (100 percent impacted). The total impact for all areas or rail yards under consideration is given by:

$$ENI = \sum_i FI_i P_i$$

Where ENI, thus, is the total equivalent number of people who are considered 100 percent impacted.

ENI Model for Rail Yards

The ENI impact analysis methodology requires the determination of the variation of L_{dn} with distance from the rail yard boundary. The basic general expression for computing L_{dn} values for each source or source group at any distance (D) from the source is:

$$L_{dn} = L_{dno} - 10 \log \left(\frac{D}{Do}\right)^n - (k_1 + k_2)(D - Do)$$

L_{dno} = baseline L_{dn} value at D_o (the yard boundary), dB.
D_o = distance from source to yard boundary, feet
n = 1 for moving sources
n = 2 for stationary sources
k_1 = combined air and ground absorption coefficient, dB/ft.
k_2 = building insertion loss coefficient, dB/ft.

The baseline L_{dn} values and k_1 values are listed in previous tables. The noise barrier (building) insertion loss coefficient (k_2) values were determined as a function of place size and average population density (ρ) range. Table 6-20 presents a summary listing of the $k_2$values.

The basic noise impact relationship is given by ENI = (FI)A , where the area (A) is a function of source type (moving, or stationary) and population density (ρ) is a function of place size and population density. range. The general equations for computing A were developed on the basis of eliminating the area inside the yard boundary from the determination of noise impact areas. The area expressions for the two different types of sources are for either segments of circles for stationary sources or rectangular strips for moving sources:

$$\frac{A}{2} = L_o(D/D_o), \text{ moving sources}$$

$$\frac{A}{2} = D^2 \cos^{-1} (D_o/D) - D_o \sqrt{D^2 - D_o{}^2} \quad , \text{ stationary source}$$

L_o = characteristic path length for moving sources.

The development of the density values applicable to the rail yard areas in terms of place size and population density range was presented in a previous section.

The characteristic path length for the switch engines and locomotives were determined on the basis of the 120 yard sample evaluated during the EPIC survey as previously discussed. The resulting L_o values ranged from 2600 to 6800 feet, depending type of yard and traffic rate.

TABLE 6-20

BARRIER (Building) INSERTION LOSS COEFFICIENTS AS A FUNCTION OF PLACE SIZE AND AVERAGE POPULATION DENSITY RANGE

Place Size (Thousands of People)	Population Density Range (people/sq.mi.)	Insertion Loss Coefficient dB/ft.
<50 and 50 to 250	<500	0
	5000 to 1000	0
	1000 to 2000	.005
	2000 to 3000	.005
	3000 to 5000	.008
	5000 to 7000	.008
	7000 to 11000	.008
>250	<1000	0
	1000 to 3000	.005
	5000 to 7000	.005
	7000 to 10000	.008
	10000 to 15000	.008
	15000 to 22000	.008

The rail yard noise model was developed to determine the noise impact resulting from groups of yard noise sources. The yard noise sources are modeled as either moving point sources or as stationary or grouped point sources. The noise emanating from each source is propagated out to the distance where the L_{dn} value is decreased to 55 dB. The noise attenuation as a function of distance depends on the type of source, the spectral distribution of noise energy, and the population density as discussed in previous sections. For each yard noise source group, the impact, given in terms of Equivalent Noise Impact (ENI), is obtained by summing the noise source group impacts over the appropriate number of yards defined by yard type, function and activity level, and receiving land use and place size population density.

To determine yard noise impact, compute the ENI for each source for each yard category according to the following sequence:

- Select yard type and noise source.
- Find L_{dno} from yard/source matrix.
- Compute L_{dn} per D for 1 or 2 dB decrements using appropriate n, k_1, and k_2 values relative to source and population density range.
- Compute FI for each successive strip area using the L_{dn} average relative to the strip boundaries.
- Compute strip area between successive D values (in accordance with the type of source).
- Compute ENI_i for each strip area using the appropriate population density value for the place size
- Sum the ENI_i values to obtain the ENI per source for the selected conditions. Multiply the ENI value by the number of rail yards in the particular yard category selected.
- Repeat the procedure and sum the ENI values for all the sources, all the population density ranges, all the place size classes and all the rail yards for the selected yard type and activity level.
- Repeat the procedure for each activity level to obtain total ENI for all the yard types selected.
- Repeat the procedure for each of the yard types and obtain the grand total ENI for all sources, yard types, activity levels, etc.

A flow diagram for the model elements and ENI computing procedure is shown in Figure 6-4. A computerized model for the rail yard noise impact assessment programmed according to the above relationships, was exercised using baseline noise level data and activity parameters to obtain the total baseline ENI for all the rail yards. Because the typical configuration of the hump and flat classification yards was asymmetrical, the near side and far side ENI values were computed separately and added to obtain the total baseline ENI.

Baseline and Study Level Impact

The results for the baseline case indicate the total noise impact under the estimated current conditions for the identified sources at all the rail yards. The estimated total equivalent number of people impacted (ENI) is 1,161,410, while the corresponding population exposed to rail yard noise of $L_{dn} \geq 55$ dB is 3,946,490. In addition, the total area surrounding the rail yards exposed to $L_{dn} \geq 55$ dB is estimated as 14,610 square miles. The baseline ENI results are shown in more detail on Table 6-21 which presents the computed ENI values for each yard type aggregated by place size. The baseline population exposed (to $L_{dn} \geq 55$ dBA) aggregated by yard type and place size are presented in the right hand columns of the table. In addition, the land areas exposed to L_{dn} values exceeding 75, 70, 65, 60, and 55 dB are also summarized by place size as shown on Table 6-22.

The relative changes in impact were computed for noise levels at the rail yard boundary reduced to L_{dn} (composite) $\leq$ 75, 70, 65 and 60 dB. A reduction to $L_{dn} \leq 60$ dB provides an indication of the minimum ENI expected in accordance with the most extensive noise reduction effort.

The composite L_{dn} at the assumed rail yard boundary distance is the level of the sum of the sound energies for the sources in the groups shown on Tables U-57 and U-6 (Appendix U). As shown on Tables 6-16 through 6-19, the largest value for composite L_{dn} was 87 dB, and the range in L_{dn} (composite) for the yard types and groups of sources was 53 to 87 dB. The selected composite boundary L_{dn} was obtained by

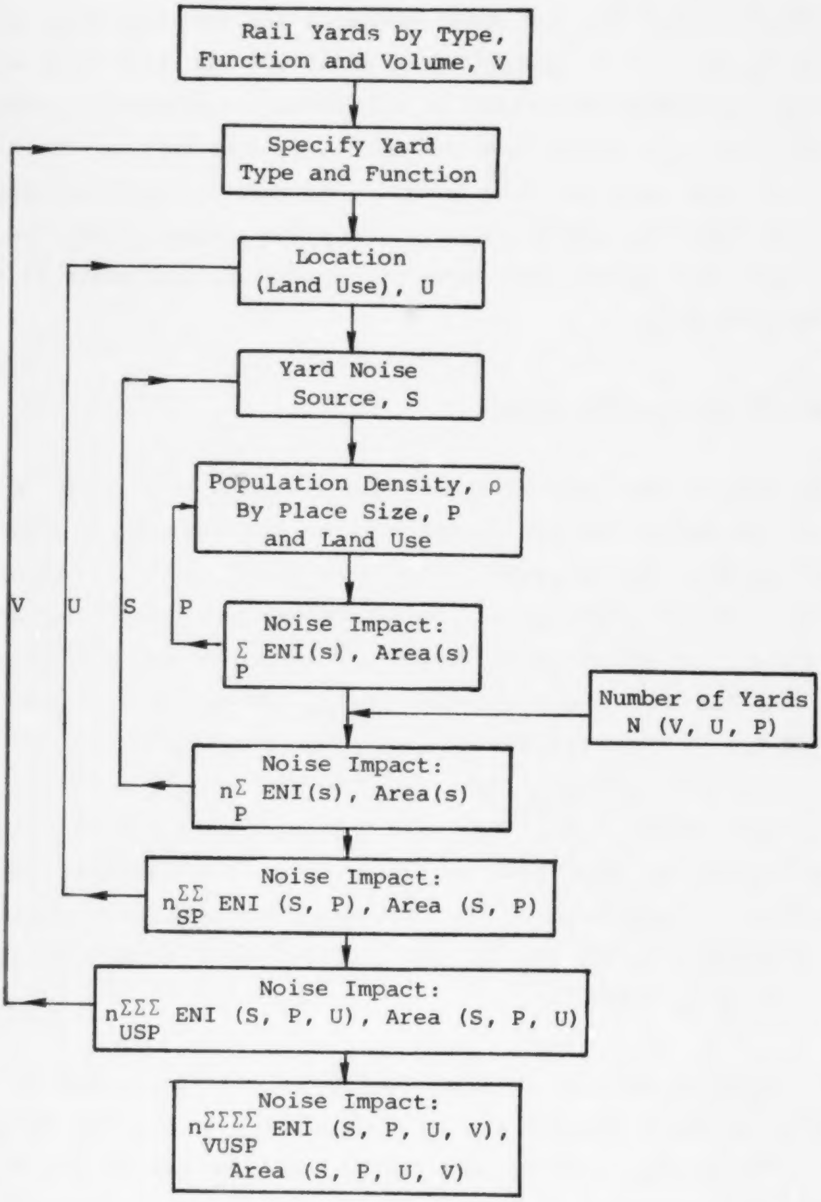

Rail Yards by Type, Function and Volume, V
Specify Yard Type and Function
Location (Land Use), U
Yard Noise Source, S
Population Density, ρ By Place Size, P and Land Use
V
U
S
P
Noise Impact: $\sum_{P}$ ENI(s), Area(s)
Number of Yards N (V, U, P)
Noise Impact: $n\sum_{P}$ ENI(s), Area(s)
Noise Impact: $n\sum\sum_{SP}$ ENI (S, P), Area (S, P)
Noise Impact: $n\sum\sum\sum_{USP}$ ENI (S, P, U), Area (S, P, U)
Noise Impact: $n\sum\sum\sum\sum_{VUSP}$ ENI (S, P, U, V), Area (S, P, U, V)

FIGURE 6-4 RAIL YARD NOISE IMPACT MODEL

TABLE 6-21

BASELINE EQUIVALENT NOISE IMPACT (ENI) AND POPULATION EXPOSED

Yard Type	Equivalent Noise Impact (ENI) Place Size <50,000 people	50,000 to 250,000 people	>250,000 people	Total	Population Exposed
Hump Yards	44,950	35,750	72,450	153,150	451,080
Flat Classification Yards	224,470	119,730	176,600	520,600	1,716,730
Industrial and Small Industrial Flat Yards	254,440	74,680	158,540	487,660	1,778,680
TOTAL	523,660	230,160	407,590	1,161,410	3,946,490

TABLE 6-22

BASELINE LAND AREA EXPOSED TO VARIOUS NOISE LEVELS

	Land Area Exposed To Given L_{dn} or Greater (Square Miles)			
L_{dn}	Place Size			
	<50,000 people	50,000 to 250,000 people	>250,000 people	Total
75	8	5	4	17
70	113	53	47	213
65	1,030	398	363	1,791
60	3,170	1,240	1,050	5,460
55	10,000	2,550	2,060	14,610

reducing the noise levels of the noisiest sources in the noisiest group first, and continuing to reduce noise source levels until the desired composite boundary L_{dn} was achieved. For example, in order to have a maximum composite boundary L_{dn} = 75 dB for any source group, composed of three sources, all individual sources would have to be reduced to an $L_{dn} \leq 70$ dB. In order to achieve a composite boundary L_{dn} no greater than 60 dB, the L_{dn} for all individual sources in the groups except for hump switcher and inbound and outbound train operations would have to be reduced to the $L_{dn} \leq 54$ dB range. Therefore, the ENI for this latter case is relatively small compared to the baseline case. A summary of the alternative study level impacts is shown in Table 6-1

The ENI value for various study levels can only be approximated due to the uncertainty in source location and grouping in each type of yard. However, a consistent procedure for successively reducing the boundary L_{dn} was utilized, and the relative change in ENI compared to the baseline case provides a good indication of the magnitude of the change in impact (or the degree of benefit obtained by reducing source noise levels). The relative change in impact, RCI, is expressed as:

$$RCI = \frac{(ENI\ baseline - ENI)}{ENI\ baseline} \times 100\ \%.$$

Also, the ENI reduction (ENI = ENI baseline - ENI) can be used as an indicator of impact change. The total ENI values obtained using the computer model for the cases outlined above were used to determine the general variation of RCI and ENI with composite L_{dn} as shown in Figure 6-5.

TABLE 6-22

BASELINE LAND AREA EXPOSED TO VARIOUS NOISE LEVELS

Land Area Exposed To Given L_{dn} or Greater (Square Miles)

L_{dn}	Place Size			
	<50,000 people	50,000 to 250,000 people	>250,000 people	Total
75	8	5	4	17
70	113	53	47	213
65	1,030	398	363	1,791
60	3,170	1,240	1,050	5,460
55	10,000	2,550	2,060	14,610

REFERENCES
SECTION 6

1. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, 550/9-74-004, U.S. EPA, Washington, D.C., March 1974.

2. 1970 Census; Population, Number of Inhabitants, United States Summary, U.S. Dept. of Commerce, Bureau of Census, PC(1)-A1, December 1971.

3. Transportation and Traffic Engineering Handbook, J. E. Baerwald, Institute of Tranportation Engineers, 1965.

4. Statistical Abstracts of the U.S., U.S. Bureau of the Census, (98th Edition), Washington, D.C., 1977.

5. Railroad Classification Yard Technology, A Survey and Assessment, S. J. Petrocek, Stanford Research Institute, Final Report, #FRA-ORD-76/304 for DOT, January 1977.

6. Assessment of Noise Environments Around Railroad Operations Jack W. Swing and Donald B. Pies, Wyle Laboratories, Contract No. 0300-94-07991, Report No. WCR 73-5, July 1973.

7. Background Document/Environmental Explanation for Proposed Interstate Rail Carrier Noise Emission Regulations, EPA #550/9-74-005; March 1974.

8. Background Document for Railroad Noise Emission Standards, EPA #550/9-76-005; December 1975.

9. Measurement of RR Noise-Line Operations, Boundaries, and Retarders, J. M. Fath, et al., National Bureau of Standards, for EPA, December 1974.

10. Noise Level Measurements of Railroad Freight Yards and Wayside, Transportation Systems Center, E. J. Rickley, et al., DOT-TSC-OST-73-46, Final Report, PB 234 219, May 1974.

11. Rail and Environmental Noise: A State of the Art Assessment, Bender, E.K., et al., Bolt, Beranek and Newman #2709, 105 pp., January 1974.

12. Diesel-Powered Heavy-Duty Refrigeration Unit Noise, Thomas J. Retka, #DOT-TSC-OST-75-5, Final Report, January 1976.

13. Highway Noise - A Design Guide for Engineers, Gordon, C.G., Galloway, W. J., Kugler, B. A., and Nelson, D. A., NCHRP Report 117, 1971.

14. Highway Noise - A Field Evaluation of Traffic Noise Reduction Measures, Kugler, B. A. and Pierson, A. G., NCHRP Report 144, 1973.

REFERENCES (Continued)
SECTION 6

15. Background Document for the Wheel and Crawler Tractor Noise Emission Regulation, U.S. EPA Report 550/90-77-250, June 1977

16. Population Distribution of the United States As a Function of Outdoor Noise Level, U.S. EPA Report 550/9-73-002, June 1974.

17. Comparison of Measured and Theoretical Single Event Noise Exposure Levels for Automotive Vehicles and Aircraft, S.R. Lane, AIAA Proceedings Transpo-LA, 1975.

SECTION 7

ANALYSIS OF COST AND ECONOMIC IMPACTS

APPROACH

This section describes the costs and economic impacts of alternative noise regulatory levels on both the railroad industry and individual rail carriers that could be affected by imposition of a noise standard. The cost and economic impacts were developed from the information previously described in the Sections 5 (Noise Control Technology) and 6 (Health and Welfare Impact). The discussion of cost and economic impacts that follows is based upon information generated from the modelling of rail yards and rail yard operations, including levels of activity, as well as the assessment of noise abatement procedures to reduce noise emissions from particular sources. As indicated previously in Section 5, the noise control technology requirements and cost estimates relied upon a preliminary version of the rail yard noise propagation model. We believe that the refinements made to this model should not significantly alter the compliance cost estimates and economic impacts analyzed.

To derive the estimated costs which represent the dollar amounts needed to comply with specific noise regulatory study levels, capital costs were derived from unit costs for an array of selected noise abatement procedures. The procedures used were described in detail in Section 5. The capital investments required then are annualized and combined with other expenditures such as operating and maintenance (O&M) costs on an annual basis to represent the total annual costs to meet the various regulatory study levels. The estimates of cost are calculated for the entire railroad industry on the basis of the universe of yards. A disaggregation of total costs to the industry is derived also in terms of individual railroad companies which own and operate rail yards for each of the analyzed regulatory study levels.

Since employment of noise abatement procedures represented but one mechanism to meet the required noise regulatory levels, another option to achieve these levels was studied, as well. This option was the purchase of land contiguous to a railyard. Estimates of the costs to meet the various noise regulatory study levels were derived using the revised health/welfare model.

The applied methodology consisted of the following analytical steps:

- Processing and tabulation of the FRA/DOT data base to array the total number (universe) of rail yards by type, function and place size,
- Estimation of the unit costs/annualized capital and operating and maintenance costs associated with noise abatement procedures that were previously identified in Section 5 as applicable to reduce noise sources in yards,
- Estimation of compliance costs related to the ability to measure yard noise at or beyond the property line using the methodology described in Appendix A,
- Estimation of compliance costs related to the employment of various combinations of noise control ("best available") technology to meet the specified regulatory study levels for the universe of yards,
- Estimation of compliance costs related to the acquisition of land by land use categories to meet the specified regulatory study levels for the universe of yards,
- Estimation of compliance costs related to employment of noise abatement procedures and noise measurement for the purpose of meeting specified regulatory study levels on a firm by firm basis (including major roads, i.e., Class I line-haul railroads, and other companies which perform line-haul and/or switching and terminal services),
- Estimation of compliance costs related to land acquisition and noise measurement for the purpose of meeting specified regulatory levels on a firm by firm basis (including major roads, i.e., Class I line-haul railroads, and other companies which perform line-haul and/or switching and terminal services.

Based upon the developed compliance cost data, additional analytical steps were performed to determine the economic impact upon the industry and on major roads. The sequence of analysis was as follows:

Based upon the developed compliance cost data, additional analytical steps were performed to determine the economic impact upon the industry and on major roads. The sequence of analysis was as follows:

- Analysis and assessment of the economic impact on the railroad industry resulting from imposition of specified regulatory study levels related to rail yards,
- Analysis and impact assessment of each major road using key financial ratios which measure the burden that noise abatement compliance costs might place on such firms at regulatory study levels of either L_{dn} 70 or L_{dn} 65,
- Determination of the economic impact on each major road and other companies resulting from compliance with rail yard noise emission regulatory study levels of either L_{dn} 70 or L_{dn} 65 using technological fixes associated with selected noise abatement procedures,

Figure 7-1 displays these and several additional analytical steps that comprise the overall methodology used in analyzing the cost and economic impacts of alternative noise standards on rail yards.

Summary of Results

Table 7-1 indicates the estimated costs to comply with various regulatory study levels related specifically to rail yard noise source emissions control. Each study level shown in Column 1 effects the universe of yards (Columns 2 and 6) considered in this analysis. This effect has been discussed previously in detail in Sections 5 and 6. Based upon the information on rail yard noise levels and the noise abatement techniques used to reach each regulatory study level for yards by type and function, the compliance costs in Columns 3 and 4, respectively, were derived. The utilization of technological fixes represented one of the two alternative noise control methods examined in the cost analysis. The other method of analysis used the noise model (described in Section 6) to calculate the total amount of land continguous to typical rail yards by type, function, place size, and activity level,

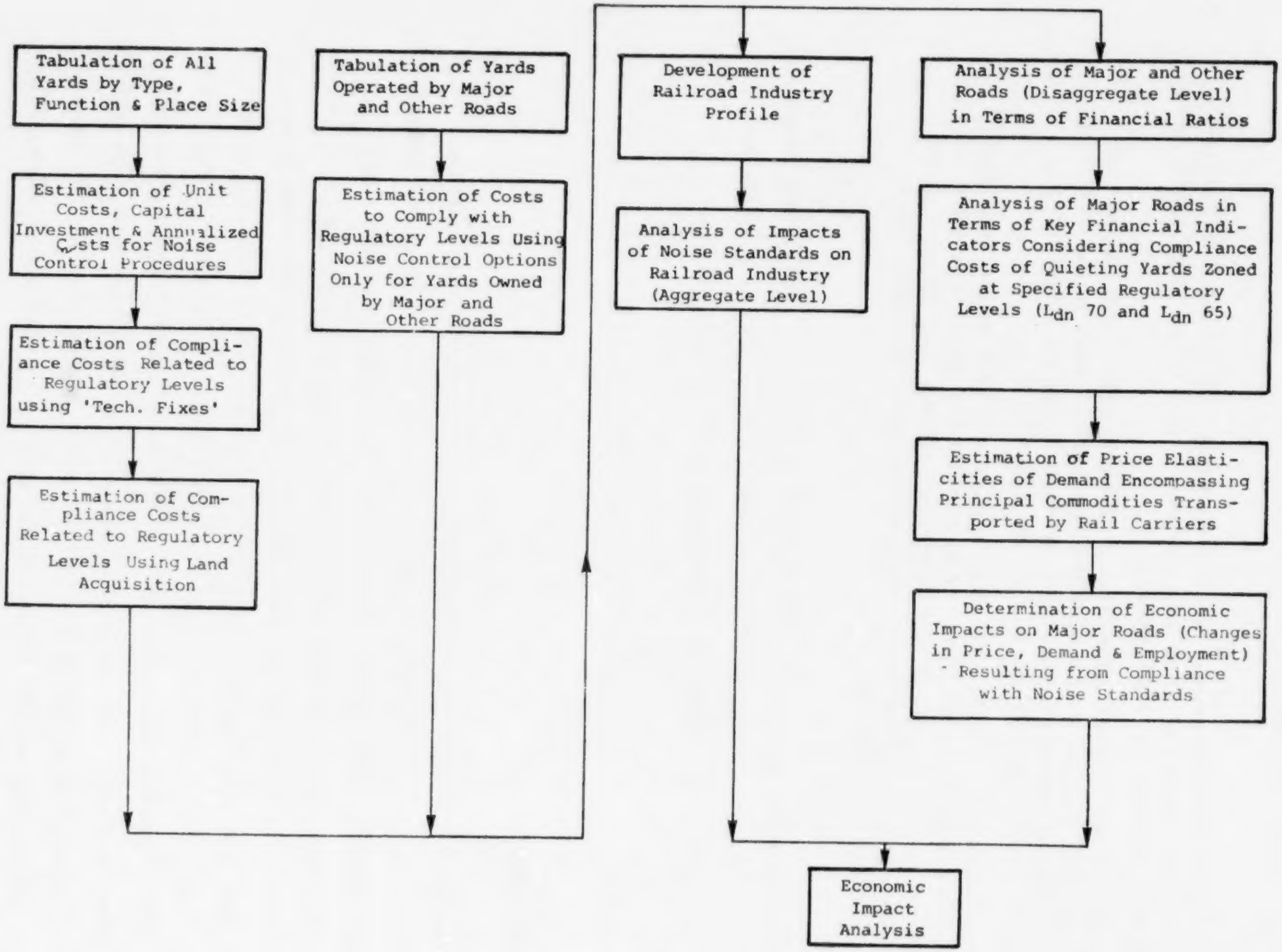

Tabulation of All Yards by Type, Function & Place Size
Estimation of Unit Costs, Capital Investment & Annualized Costs for Noise Control Procedures
Estimation of Compliance Costs Related to Regulatory Levels using 'Tech. Fixes'
Estimation of Compliance Costs Related to Regulatory Levels Using Land Acquisition
Tabulation of Yards Operated by Major and Other Roads
Estimation of Costs to Comply with Regulatory Levels Using Noise Control Options Only for Yards Owned by Major and Other Roads
Development of Railroad Industry Profile
Analysis of Impacts of Noise Standards on Railroad Industry (Aggregate Level)
Analysis of Major and Other Roads (Disaggregate Level) in Terms of Financial Ratios
Analysis of Major Roads in Terms of Key Financial Indicators Considering Compliance Costs of Quieting Yards Zoned at Specified Regulatory Levels (L_{dn} 70 and L_{dn} 65)
Estimation of Price Elasticities of Demand Encompassing Principal Commodities Transported by Rail Carriers
Determination of Economic Impacts on Major Roads (Changes in Price, Demand & Employment) Resulting from Compliance with Noise Standards
Economic Impact Analysis

FIGURE 7-1. FLOW DIAGRAM OF ANALYTICAL STEPS ENCOMPASSING COST & ECONOMIC IMPACT ANALYSIS

TABLE 7-1

SUMMARY OF ESTIMATED COMPLIANCE COSTS

Study Level (L_{dn})	All Yards					Yards of Class I Roads (1976/77) Only (Technological Fixes)		
	(Technological Fixes)			(Land Acquisition)				
(1)	No. of Yards (2)	Capital Costs ($000) (3)	Annualized Costs ($000) (4)	Capital Costs ($M) (5)	Annualized Costs ($M) (6)	No. of Yards (7)	Capital Costs ($000) (8)	Annualized Costs ($000) (9)
75	1,237	$ 37,820	$ 9,848	$ 1,878	$ 306	1,164	$ 41,944	$ 13,181
70	2,618	49,754	16,798	25,825	4,210	2,347	48,004	15,445
65	4,169	639,017	355,009	239,100	38,973	3,696	576,980	325,322
60	4,169	883,328	450,976	564,940	92,084	3,696	807,493	415,880
65 NC 70 C	3,352	311,922	165,471	211,834	34,530	2,969	271,932	148,655

C = Compatible (Industrial/Agricultural)

NC = Non-Compatible (Residential/Commercial) that was contained within contours beyond the yard property at various regulatory study levels. Using the land areas computed for each level and estimates of costs to purchase various categories of land, the capital and annual costs were derived and shown in Columns 5.and 6, respectively.

The estimated costs of noise abatement procedure implementation were developed also for the major roads (Class I line-haul railroads in the year 1976/1977). These roads owned and operated approximately 90 percent of the rail yards comprising this universe. Each major road's yards were tabulated by type and function and the costs for noise reduction to reach the indicated study levels were computed; these are shown in Columns 8 and 9 in terms of capital investment (initial year) and annualized expenditures including capital recovery and other expenses.

To illustrate the relative impact of the estimated compliance costs on the railroad industry, Table 7-2 was developed. This table contains two (2) key industry financial indicators, specifically the capital expenditures and operating expenses, in the year 1976, which provide a basis for comparing the effect of potential noise standards on the railroad industry. Two regulatory study levels and the estimated costs of compliance associated with the two options studied were selected and are shown in this table.

Based upon the compliance cost estimates to meet the indicated regulatory levels shown in Table 7-1, estimates of the economic impacts on the industry and major roads were developed. To measure the economic impacts at the aggregate (industry) and disaggregate (individual roads) the price elasticity of demand which is a necessary and key variable in such an analysis had to be derived and applied.

Since data about demand responses to price changes for individual markets and roads were not readily available, a 'best' estimate on an industry-wide basis was derived. This 'best' estimate, representing upper and lower values for the likely range of elasticities, was calculated using elasticity ranges obtained from several reports; the estimate

TABLE 7-2

SUMMARY OF COST IMPACTS FOR THE RAILROAD INDUSTRY

Noise Regulation	Abatement Procedure	Cost ($M)		Cost Increase (%)	
		Capital	Annualized	Capital	Annualized
Unregulated	--	$ 1,700*	$14,900*	0.0	0.0
L_{dn} 70	Noise Source	50	17	3.0	0.1
	Land Acquisition	25,825	4,210	1519.0	28.3
L_{dn} 65	Noise Source	639	355	37.6	2.4
	Land Acquisition	239,100	38,973	14,064.7	261.6

* Costs indicated represent actual Class I line-haul railroad capital expenditures and operating expenses for 1976 (Source: The 1977 Yearbook of Railroad Facts, 1978 Edition, Association of American Railroads).

consists of a weighted average price elasticity representing the major classes of commodities transported by railroads. Use was made of these estimates of price elasticity to determine and assess the relative economic impacts presented in this study.

Table 7-3 summarizes the key economic impacts obtained from the analysis performed. Two regulatory study levels are shown along with the upper and lower values for the likely range of elasticities. Based on the application of a micro-economic modeling technique, changes in prices, demand and employment were computed. Results from the computations made for these parameters are presented in Table 7-3 in terms of minimum, average (or median) and maximum values. A reference point is given in terms of actual 1976 industry data for these same parameters to show the potential impact of compliance with noise standards at the regulatory study levels previously indicated above. Since the data available on the major roads did not distinguish between yards on the basis of land use, the derived impacts represent a range of potential changes in the specified parameters (i.e., upper and lower limits).[a]

ESTIMATED COST OF NOISE ABATEMENT

Introduction

This section describes the key steps used to develop the estimated costs for two approaches of noise control. The approaches examined were: (1) employment of selected noise abatement procedures (which was previously detailed in Section 5); and (2) the acquisition of land areas by category of land use which are contiguous to rail yards. A third approach that involves rail carrier management and practices affecting rail yard operations was considered as another alternative, but is not addressed because costs concerning this alternative are not available from existing reference sources.

TABLE 7-3

SUMMARY OF ECONOMIC IMPACTS FOR THE RAILROAD INDUSTRY

		STUDY LEVELS				Industry Characteristics for 1976 At the Individual Railroad Level*		
		L_{dn} 65 dB		L_{dn} 70 dB				
		Price Elasticity of Demand						
		$\varepsilon_d = -1.41$	$\varepsilon_d = -0.39$	$\varepsilon_d = -1.41$	$\varepsilon_d = -0.39$			
Price	Minimum	0.0%	0.0%	0.0%	0.0%	Price	Minimum	1.7
Increase/firm	Average	3.3%	2.3%	0.2%	0.2%	c/Ton-Mile	Mediam	2.4
(Percentage)	Maximum	6.8%	4.9%	0.8%	0.5%		Maximum	10.8
Demand	Minimum	0.0%	0.0%	0.0%	0.0%	Demand	Minimum	154
Decrease/firm	Average	4.6%	0.4%	0.3%	0.1%	(Millions	Median	3,482
(Percentage)	Maximum	9.6%	1.9%	1.1%	0.2%	of Ton-Miles)	Maximum	94,400
Employment	Minimum	1	0	0	0	Employment	Minimum	276
Decrease/firm	Average	249	52	11	2	(No. of	Median	2,645
(No. of People)	Maximum	3,056	714	119	29	People)	Maximum	98,800

* Data on industry represents Class I line-haul railroads.

Noise Source Abatement Cost Estimates

The procedure used for the development of source noise control cost estimates is summarized in the following sequential steps:

Step 1. Identify noise sources located in rail yards.

Step 2. Identify noise abatement procedures that can be applied to each source.

Step 3. Estimate the noise abatement resulting from the application of each procedure.

Step 4. Determine the number and type of procedures which must be applied to achieve selected noise levels at yard boundaries.

Step 5. Estimate the costs incurred to apply each procedure.

Step 6. Calculate the costs incurred to apply all necessary procedures.

Step 7. Estimate the costs incurred to measure yard noise levels.

Step 8. Calculate the total costs to achieve specified maximum noise levels at yard boundaries for all rail yards.

Step 9. Develop cost estimates to achieve the same maximum noise level at yard boundaries through the acquisition of additional property around each yard.

Step 10. Apply the above cost estimates to all major and other railroad companies.

The source noise control approach (Steps 1 through 8 above) consists of the application of selected noise abatement procedures to specific types of rail yards. The association of these abatement procedures to railyards as a function of study noise levels at yard property lines is displayed in Table 7-4. (This information is also shown in Table 7-5.) It should be noted that the type of abatement procedure, the number of procedures employed, and the resulting noise level are based upon medium levels of car switching activity in all of the hump and flat classification yards.

The estimated costs of each of the eight abatement procedures summarized in Table 7-4 are displayed in Table 7-5. These data, which are developed from unit cost information contained in Appendix C,

TABLE 7-4

ABATEMENT PROCEDURES FOR ACHIEVING STUDY LEVELS IN YARDS

Yard Type	Study Level	Abatement Procedures P_1	P_2	P_3	P_4	P_5	P_6	P_7
Hump*	Level 1	X						
	Level 2	X				X	X	
	Level 3	X		X	X	X	X	
	Level 4	X	X		X	X	X	X
Flat* (Classification)	Level 1					X	X	
	Level 2					X	X	
	Level 3					X	X	X
	Level 4					X	X	X
Flat (Industrial/Small Industrial)	Level 1	(Current L_{dn} below Level 1)						
	Level 2					X		
	Level 3					X		X
	Level 4					X		X

*Procedures apply for medium level of car switching activity in classification yards

Abatement Procedures

P_1 Retarder Barriers

P_2 Lubrication of Retarders

P_3 Ductile Iron Shoes

P_4 Replace Non-Releasable with Releasable Inert Retarder

P_5 Switch Engine Treatment

P_6 Relocate Structure/Load Test Site

P_7 Reschedule to Reduce Nighttime Activities and/or Number of Classifications

P_8 Refrigerator Car Treatment (Applies to all study levels)

TABLE 7-5

CAPITAL AND ANNUALIZED COSTS OF YARD NOISE ABATEMENT PROCEDURES

Procedure Number	Procedure	Capital Cost ($/Yard)	Annualized Cost ($/Yard)	Remarks
P_1	Retarder Barriers:			
	Master	22,500	3,663 1,125	Capital Recovery Maintenance
	Group	90,000	14,645 4,500	Capital Recovery Maintenance
P_2	Lubrication of Retarders	1,750,000	284,814 189,000	Capital Recovery Lubricant
P_3	Ductile Iron Shoes	0	112,000	Maintenance
P_4	Releasable Retarders	322,258	52,444 32,226	Capital Recovery Maintenance
P_5	Switch Engine Treatment	3,000	790 580	Capital Recovery Additional Fuel
P_6	Relocate/Enclose Load Test Site	90,000	9,548 9,000	Capital Recovery Maintenance
P_7	Reschedule Night Activities:			
	Hump Yards	220,250	24,798 387,000	Capital Recovery Operations & Maintenance
	Flat Classification Yards	220,250	24,798 167,000	Capital Recovery Operations & Maintenance
	Industrial Yards	220,250	24,798 39,000	Capital Recovery Operations & Maintenance
	Small Industrial Yards	0	8,000	Operations & Maintenance
P_8	Refrigerator Cars	110*	14*	Capital Recovery

* Refrigerator Car Capital and Annualized Costs are presented on a cost per car basis.

include estimates for initial capital investment, operations and maintenance, and amounts for capital recovery. The costs for each abatement procedure are shown on a per rail yard basis except for refrigerator cars as noted.

Capital costs are the initial costs, or the investments, that would be required to procure and install each noise control procedure. Capital cost is the product of the unit cost and the quantity required for each yard and includes both the procurement and the installation cost of each procedure. The annualized costs are total costs expressed on an annual basis. These costs include operating costs, such as maintenance and fuel, as well as an amount for capital recovery. The elements of capital recovery include a 10 percent interest factor and the expected useful life for each type of control technique, as indicated in Appendix C. The costs shown are estimates of the incremental costs that would be incurred for the addition of new equipment, the modification of existing equipment, or by changing operational methods.

The estimated cost to the railroad industry for the measurement of yard noise levels is approximately $5.9 million in capital investment for instrumentation and approximately $4.4 million in operations and maintenance.

The total costs incurred by the railroad industry to achieve the specified study noise levels at the rail yard property line for all yard types are presented in the next series of tabulations.

Table 7-6 presents the results of the cost estimating calculations to achieve study noise level 1 (i.e. L_{dn} 75) at railyard property lines. As shown in this display, noise abatement procedures are required for hump and flat classification yards and the refrigerator car fleet. The procedures employed are refrigerator car treatment, retarder barriers, switch engine treatment, and load test cell treatment in flat yards. Estimates for the cost of yard noise level measurement are also included.

TABLE 7-6

COST ESTIMATES FOR NOISE ABATEMENT OF U.S. RAILROADS
Study Level 1 (L_{dn} 75)

Noise Sources		Control Techniques			Capital Costs ($000)	Annualized Costs ($000)	Notes
Type	Quantity Existing	Type	Quantity Required	Unit Cost $			
Hump Yards: 124							
Master Retarders	124	Barrier Sets	124	$ 22,500	2,790	454 140	CR Maintenance
Group Retarders	744	Barrier Sets	744	15,000	11,160	1,816 558	CR Maintenance
Measurement	124	Instr.	124	10,000	1,240	327 124 131	CR Maintenance Labor
SUB TOTAL LEVEL 1 HUMP YARD COSTS					15,190	3,550	
Flat Classification Yards: 1113							
Switch Engines	2,783	Mufflers and Fan Treatment	2,783	1,200	3,340	881 646	CR Additional Fuel
Load Test Site	185	Relocate or Enclose	185	90,000	16,650	1,765 1,665	CR Maintenance
Measurement	1,113					1,013	Labor
SUB TOTAL LEVEL 1 FLAT CLASSIFICATION YARD COSTS					19,990	5,970	
Refrigerator Cars	24,000	Mufflers and Fan Treatment	24,000	110	2,640	328	CR
GRAND TOTAL					37,820	9,848	

* Capital Recovery

Table 7-7 summarizes the cost calculations for study noise level 2 (i.e. L_{dn} 70). Noise abatement procedures are required for hump and flat classification yards and for industrial rail yards to achieve this maximum noise level. The procedures used are retarder barriers, switch engine treatment, load test cell treatment, and refrigerator car treatment. Estimates of the cost to measure yard noise levels are also shown for the railyard network.

Cost results for study level 3(i.e. L_{dn} 65) are displayed in Table 7-8. At this level all 4169 of the known railyard inventory require the application of noise abatement procedures. These procedures include the treatment of refrigerator cars, retarders, switch engines, and load test cells. Retarder treatments require the use of barriers, ductile iron shoes, and the introduction of releasable retarders at the departure end of hump yard classification bowls. This study level also requires the curtailment of night operations in flat classification and industrial yards between 2200 and 0700 hours. Measurement costs for all yards are also included.

The estimated costs to the railroad industry to achieve study noise level 4 (i.e. L_{dn} 60) at all rail yard property lines are presented in Table 7-9. At this level the procedures employed include retarder barriers, the installation of lubrication systems for master and group retarders, the use of releasable retarders, switch engine treatment, refrigerator car treatment, load test cell enclosure or relocation, and the curtailment of all rail yard operations from 2200 to 0700 hours. The costs shown also include the measurement of all railyard noise levels.

An examination of the estimated cost to the railroad industry for a mix of study noise levels which specify a maximum noise level as a function of the location of rail yards is presented in Table 7-10. Here rail yards located in industrial or agricultural land use environments must achieve L_{dn} 70 and yards in residential or commercial environments must achieve L_{dn} 65. These data show that approximately 2300 rail yards are considered to be located in compatible land use

TABLE 7-7
COST ESTIMATES FOR NOISE ABATEMENT OF U.S. RAILROADS
Study Level 2 (L_{dn} 70)

Noise Sources		Control Techniques			Capital Costs ($000)	Annualized Costs ($000)	Notes
Type	Quantity Existing	Type	Quantity Required	Unit Cost $			
Hump Yards: 124							
Master Retarders	124	Barrier Sets	124	$ 22,500	2,790	454 140	CR Maintenance
Group Retarders	744	Barrier Sets	744	15,000	11,160	1,816 558	CR Maintenance
Switch Engines	310	Mufflers and Fan Treatment	310	1,200	372	98 72	CR Additional Fuel
Load Test Site	31	Relocate or Enclose	31	90,000	2,790	296 279	CR Maintenance
Measurement	124	Instr.	124	10,000	1,240	327 124 131	CR Maintenance Labor
SUB TOTAL LEVEL 2 HUMP YARD COSTS					18,352	4,295	
Flat Classification Yards: 1113							
Switch Engines	2,783	Mufflers and Fan Treatment	2,783	1,200	3,340	881 646	CR Additional Fuel
Load Test Site	185	Relocate or Enclose	185	90,000	16,650	1,765 1,665	CR Maintenance
Measurement	1,113					1,013	Labor
SUB TOTAL LEVEL 2 FLAT CLASSIFICATION YARD COSTS					19,990	5,970	
Industrial Yards: 1381							
Switch Engines	3,452	Mufflers and Fan Treatment	3,452	1,200	4,142	1,093 801	CR Additional Fuel
Measurement	2,932	Instr.	463	10,000	4,630	1,221 463 2,627	CR Maintenance Labor
SUB TOTAL LEVEL 2 INDUSTRIAL YARDS					8,772	6,205	
Refrigerator Cars	24,000	Mufflers and Fan Treatment	24,000	110	2,640	328	CR
GRAND TOTAL					49,754	16,798	

TABLE 7-8

COST ESTIMATES FOR NOISE ABATEMENT OF U.S. RAILROADS
Study Level 3 (L_{dn} 65)

Noise Sources		Control Techniques			Capital Costs ($000)	Annualized Costs ($000)	Notes
Type	Quantity Existing	Type	Quantity Required	Unit Cost $			
Hump Yards: 124							
Master Retarders	124	Barrier Sets	124	$ 22,500	2,790	454 140	CR Maintenance
Group Retarders	744	Barrier Sets	744	15,000	11,160	1,816 558	CR Maintenance
Switch Engines	310	Mufflers and Fan Treatment	310	1,200	372	98 72	CR Additional Fuel
Master and Group Retarders	124	Ductile Iron Shoes	124	112,000*		13,861	Maintenance
Inert Retarders	3,996	Releasable Retarders	3,996	10,000	39,960	6,503 3,993	CR Maintenance
Load Test Site	31	Relocate or Enclose	31	90,000	2,790	296 279	CR Maintenance
Measurement	124	Instr.	124	10,000	1,240	327 124 131	CR Maintenance Labor
SUB TOTAL LEVEL 3 HUMP YARD COSTS					58,312	28,655	
Flat Classification Yards: 1113							
Switch Engines	2,783	Mufflers and Fan Treatment	2,783	1,200	3,340	881 646	CR Additional Fuel
Load Test Site	185	Relocate or Enclose	185	90,000	16,650	1,756 1,665	CR Maintenance
Measurement	1,113					1,013	Labor
Night Yard Noise	1,113	Reschedule Night Act.	1,392	176,000	245,182**	186,000 27,607	O&M CR
SUB TOTAL LEVEL 3 FLAT CALSSIFICATION YARD COSTS					265,172	219,577	
Industrial Yards: 2932							
Night Yard Noise	2,932	Reschedule Night Act.	1,726	176,000	304,121**	66,000 34,244	O&M CR
Switch Engines	3,452	Mufflers and Fan Treatment	3,452	1,200	4,142	1,093 801	CR Additional Fuel
Measurement	2,932	Instr.	463	10,000	4,630	1,221 463 2,627	CR Maintenance Labor
SUB TOTAL LEVEL 3 INDUSTRIAL YARD COSTS					312,893	106,449	
Refrigerator Cars	24,000	Mufflers and Fan Treatment	24,000	110	2,640	328	CR
GRAND TOTAL					639,017	355,009	

* Cost includes both master and group retarder shoe replacement per year for each yard.

** 50% more switch engines with muffler and fan treatment included.

TABLE 7-9

COST ESTIMATES FOR NOISE ABATEMENT OF U.S. RAILROADS
Study Level 4 (L_{dn} 60)

Noise Sources		Control Techniques			Capital Costs ($000)	Annualized Costs ($000)	Notes
Type	Quantity Existing	Type	Quantity Required	Unit Cost $			
Master Retarders	124	Barrier Sets	124	$ 22,500	2,790	454 140	CR Maintenance
Group Retarders	744	Barrier Sets	744	15,000	11,160	1,106 558	CR Maintenance
Switch Engines	310	Mufflers and Fan Treatment	310	1,200	372	98 72	CR Additional Fuel
Master and Group Retarders	868	Lubrication Systems	868	250,000	217,000	35,317 23,436	CR Lubricant
Inert Retarders	3,996	Releasable Retarders	3,936	10,000	39,960	6,503 3,996	CR Maintenance
Load Test Site	31	Relocate or Enclose	31	90,000	2,790	296 279	CR Maintenance
Night Yard Noise	124	Reschedule Night Act.	155	176,000	27,311*	48,000 3,075	O&M CR
Measurement	124	Instr.	124	10,000	1,240	327 124 131	CR Maintenance Labor
SUB TOTAL LEVEL 4 HUMP YARD COSTS					302,623	124,622	
Flat Classification Yards: 1113							
Switch Engines	2,783	Mufflers and Fan Treatment	2,783	1,200	3,340	881 646	CR Additional Fuel
Load Test Site	185	Relocate or Enclose	185	90,000	16,650	1,765 1,665	CR Maintenance
Measurement	1,113					1,013	Labor
Night Yard Noise	1,113	Reschedule Night Act.	1,392	176,000	245,182*	186,000 27,607	O&M CR
SUB TOTAL LEVEL 4 FLAT CLASSIFICATION YARD COSTS					265,172	219,577	
Industrial Yards: 2932							
Night Yard Noise	2,932	Reschedule Night Act.	1,726	176,000	304,121*	66,000 34,244	O&M CR
Switch Engines	3,452	Mufflers and Fan Treatment	3,452	1,200	4,142	1,093 801	CR Additional Fuel
Measurement	2,932	Instr.	463	10,000	4,630	1,221 463 2,627	CR Maintenance Labor
SUB TOTAL LEVEL 4 INDUSTRIAL YARD COSTS					312,893	106,449	
Refrigerator Cars	24,000	Mufflers and Fan Treatment	24,000	110	2,640	328	CR
GRAND TOTAL					883,328	450,976	

* 50% more switch engines with muffler and fan treatment.

TABLE 7-10

ESTIMATED COSTS OF COMPLIANCE WITH MIXED STANDARDS BY YARD TYPE
(L_{dn} 70/65)

	Number	Capital Costs Per Yard ($000)	Total Capital Cost ($000)	Annualized Costs Per Yard ($000)	Total Annualized Cost ($000)
126 HUMP CLASSIFICATION/ INDUSTRIAL YARDS					
Compatible: (L_{dn} 70)					
High Load Test	10	205.9	2,059	43.8	438
Other	31	115.5	3,580	25.3	784
SUB TOTAL	41		5,639		1,222
Non-Compatible: (L_{dn} 65)					
High Load Test	11	527.8	5,806	240.2	2,642
Other	32	437.8	14,010	221.7	7,094
SUB TOTAL	43		19,816		9,736
TOTAL FOR HUMP YARDS	84		25,455		10,958
1113 FLAT CLASSIFICATION YARDS					
Compatible: (L_{dn} 70)					
High Load Test	41	84.7	3,473	29.6	1,216
Other	266	3.5	918	1.6	426
SUB TOTAL	307		4,391		1,642
Non-Compatible: (L_{dn} 65)					
High Load Test	85	311.3	26,460	212.8	18,088
Other	487	196.1	95,500	180.3	88,300
SUB TOTAL	572		121,970		105,592
TOTAL FOR FLAT CLASS. YARDS	879		126,376		107,234
2816 INDUSTRIAL YARDS					
Compatible: (L_{dn} 75)					
Industrial	870	3.0	1,601	1.0	458
Small Industrial	600	0	0	0	0
SUB TOTAL	1,470		1,601		458
Non-Compatible: (L_{dn} 80)					
Industrial	460	320.4	147,384	88.3	40,598
Small Industrial	956	0	0	4.4	4,214
SUB TOTAL	1,416		147,384		45,057
TOTAL FOR INDUSTRIAL YARDS	2,886		148,985		45,515
REFRIGERATOR CARS	10,000		2,000		338
MAINTENANCE	1,950		2,870		1,116
GRAND TOTAL			311,311		207,471

environments (i.e. industrial or agricultural). The remaining rail yards (approximately 1869 yards) are in non-compatible environments (i.e. residential or commercial). The costs incurred by the railroad industry to achieve rail yard noise levels of L_{dn} 70 for 2300 yards and L_{dn} 65 for 1869 yards are reflected in this table. Cost estimates for the treatment of the refrigerator car fleet and the accomplishment of yard noise level measurement are also included. It should be noted that Table 7-10 consists of unit costs, etc., related to and found in Tables 7-7 and 7-8 respectively.

Data and information presented in Tables 7-6, 7-7, 7-8 and 7-9 formed the basis of the various regulatory options considered in the decision making process. More than 100 options were initially considered and these were narrowed down to five. Additional costing analyses were conducted, as necessary, to enable the decision makers to compare options. Appendix L presents a summary of the additional cost analyses.

The information of Appendix L led to the selection of option 4 as the candidate option for the proposed rulemaking. To further assess the impact of the candidate option on railroad companies, financial analyses were conducted and are presented in Appendix F.

Land Purchase to Meet Noise Regulatory Study Levels

The following procedure was used to estimate the costs for land acquisition. Land acquisition represents the other option analyzed for the purpose of meeting the specified noise regulatory study levels. The preceding section (Section 6) described the analytical methodology followed for calculating the environmental noise impact on the population exposed to railyard noise. A similar analytical approach was used to calculate areas beyond railyard property lines by yard type, level of activity and place size.

To develop the estimated costs for acquiring land to meet the various noise regulatory study levels that are used in these areas, a step-by-step procedure was followed that is described below.

Step 1. Using the selected rail yards which were drawn at random within the yard type and place size matrix (see Section 6 for a detailed discussion of this procedure), U.S. Geological Survey maps and other sources were processed to construct map overlays containing the identification of areas by land use beyond the railyard property line out to a distance of roughly 2000 yards around each yard. The land use categories indicated were in terms of non-compatible land (i.e. residential and commercial), compatible land (i.e. industrial and agricultural), and undeveloped land.

Step 2. Each yard map overlay was analyzed to determine the percentage of land related to the 5 land use categories.

Step 3. Statistical analysis was performed using the information developed in Step 2. The analyses was performed to derive a typical or average model for each of the 12 cells comprising the railyard type and place size matrix in terms of the 5 land use categories. The results of this analysis are presented in Appendix D.

Step 4. Estimates of cost to purchase land for each land use category were developed on the basis of information that was collected from various sources.[1, 2, 3] Listed below are the estimated costs (current dollars per square foot) to purchase the various land categories.

Land Use Categories	Estimated 1978 Land Prices (dollars/square foot)
Residential	
● Single dwelling unit	$ 4.86
● Multiple dwelling unit	30.43
Commercial	5.51
Industrial	1.66
Agricultural	0.01
Undeveloped*	0.01

*Assumed equivalent to agricultural land prices.

Additional information about the derivation of the indicated prices is presented in Appendix E.

Step 5. A computer program which represents yards by type, level of activity and place size was executed for several cases to calculate areas beyond the yard property-line contained within specific noise levels at 5 dB increments starting from a pre-determined baseline level. The cases examined included calculation of areas assuming: (a) existing environment, no noise abatement procedures used; (b) L_{dn} 75, 70 and 65, TABLE F-11

LAND ACQUISITION COSTS FOR VARIOUS REGULATORY STUDY LEVELS WITHOUT EMPLOYMENT OF NOISE CONTROL TECHNOLOGY (BASELINE CASE*)

Type of Yard	COST (Millions of Dollars) BY REGULATORY STUDY LEVELS									
	L_{dn} 75		L_{dn} 70		L_{dn} 65		L_{dn} 60		L_{dn} 70/65	
	Cap.	Ann.	Cap.	Ann.	Cap.	Ann.	Cap.	Ann.	Cap.	Ann.
Hump	1,270	207	7,786	1,270	27,588	4,497	47,420	7,729	26,349	4,295
Flat	606	99	18,039	2,940	122,003	19,886	182,436	29,737	104,942	17,106
Industrial	-	-	-	-	89,509	14,590	281,039	45,809	80,543	13,129
Small Ind.	-	-	-	-	-	-	54,045	8,809	-	-
Total	1,876	306	25,825	4,210	239,100	38,973	564,940	92,084	211,834	34,530

* Baseline noise levels and land areas related to low, medium and high activity levels for hump and flat yards and typical activity levels for industrial/small industrial yards.

Cap. = Capital costs

Ann. = Annualized costs

TABLE 7-12

LAND ACQUISITION COSTS FOR VARIOUS REGULATORY STUDY LEVELS, ASSUMING EMPLOYMENT OF NOISE CONTROL TECHNOLOGY TO MEET L_{dn} 75 AT PROPERTY LINES OF HUMP AND FLAT YARDS

Type of Yard	COST (Millions of Dollars) BY REGULATORY STUDY LEVELS							
	L_{dn} 70		L_{dn} 65		L_{dn} 60		L_{dn} 70/65	
	Cap.	Ann.	Cap.	Ann.	Cap.	Ann.	Cap.	Ann.
Hump	3,864	629	20,116	3,279	57,636	9,395	18,638	3,038
Flat	15,294	2,493	121,000	19,723	315,178	51,374	113,722	18,537
Total	19,158	3,122	141,116	23,002	372,814	60,769	132,360	21,575

TABLE 7-13

LAND ACQUISITION COSTS FOR VARIOUS REGULATORY STUDY LEVELS, ASSUMING EMPLOYMENT OF NOISE CONTROL TECHNOLOGY TO MEET L_{dn} 70 AT PROPERTY LINES OF HUMP, FLAT AND INDUSTRIAL YARDS

Type of Yard	COST (Millions of Dollars) BY REGULATORY STUDY LEVELS					
	L_{dn} 65		L_{dn} 60		L_{dn} 70/65	
	Cap.	Ann.	Cap.	Ann.	Cap.	Ann.
Hump	7,621	1,242	35,214	5,740	6,929	1,129
Flat	47,887	7,806	207,259	33,430	44,917	7,321
Industrial	-	-	74,080	12,075	-	-
Total	55,508	9,048	316,453	51,245	51,846	8,450

Cap. = Capital costs
Ann. = Annualized costs

respectively, at property-line of yards using noise abatement procedures as specified previously in this Section. Appendix D contains the data indicated in the areas contained within the various noise levels.

Step 6. Using the results of Step 5 and combining them with the products of Steps 3 and 4, the estimated cost to purchase land was calculated. The capital costs are shown by type of yard by the various noise regulatory study levels. The grand total or bottom line capital costs are indicated also for each study level. Table 7-11 represents the case where noise abatement procedures are not used. Table 7-11 contains the estimated annual owning expenses for real estate which amounts to approximately 13 percent of the original land purchase price. Appendix D discusses this subject in further detail. The additional tables encompassing Tables 7-12 and 7-13, are formatted in a similar way to that of Table 7-11; however, the cases presented reltae uow to employment of selected noise abateuent procedures to meet the specified regulatory study levels.

POTENTIAL COST BURDEN ON INDIVIDUAL RAIL CARRIERS (MAJOR AND OTHER ROADS)

The expected cost of compliance with a noise regulation will not fall equally or proportionally on individual railroads. This section examines each individual major railroad company in terms of the numbers of yards owned by type. This information was extracted from the FRA/DOT data base.[2] Some firms have a disproportionately large number of railroad yards, while others have a smaller number compared with the size of their operations. The rail carriers which have a relatively larger number of yards would be expected to bear a disproportionately larger cost burden than those with relatively fewer yards.

Table 7-14 presents three groupings of railroad firms with: (1) an above average number of yards, (2) an average number of yards, and (3) a below average number of railroad yards. The criterion used to calculate proportionality was revenue ton-miles. If a company owns about the same percentage of the total number of yards as its percentage of the total ton-miles of revenue, it is considered average. If the percentage of yards it owns is small compared to the percentage of revenue ton-miles it operates, it is classified as below average. Table 7-15 shows the regional classification of the rail carriers, too.

TABLE 7-14

DISTRIBUTION OF CLASS I LINE-HAUL RAILROADS (UNIFORM ALPHA CODE)* ACCORDING TO THE RELATIVE NUMBER OF YARDS OWNED

	CLASS I LINE-HAUL RAILROADS BY ICC DISTRICTS ICC DISTRICTS IN THE YEAR, 1976.		
INDEX	EASTERN DISTRICT	SOUTHERN DISTRICT	WESTERN DISTRICT
ABOVE AVERAGE	BLE CP NW	CCO LN SOU	ATSF BN DRGW DWP MP SSW SP UP
AVERAGE	CO RFP	FEC ICG	DMIR FWD KCS SLSF SOO WP
BELOW AVERAGE	BO BAR BM CV CEI CONRAIL DH DTS DTI EJE GTW ITC LI MEC PLE WM	GA SCL	CNWT MILW RI CS MKT NWP TN TPW

* Names of each railroad company associated with this list are presented in Appendix F and are keyed by the Uniform Alpha Code noted above. The number of yards related to each road are listed in Appendix E.

This table should be interpreted with caution, as there is an implied assumption that the yards are homogeneous. It is possible for a railroad company with a disproportionately large number of yards actually to experience less than average costs to quiet their yards. However, if the costs are typical, the above average companies would bear a larger part of the total; the average companies would incur average costs; and the below average group would incur less than average expenses.

In previous tables (7-6, 7, 8, and 9) compliance costs were estimated by yard type for each study level. Using the FRA/DOT data base the numer of yards by function and type were tabulated for each major road. On the basis of the data developed by yard function and type, the following tables (Tables 7-15, -16, -17, and -18) were derived, and these data represent cost estimates for each individual major railroad company. The railroad companies are grouped by region and indicate the estimated compliance costs to meet the specified L_{dn} study levels. Appendices E and F respectively contain information about the number of yards owned by firm and the Uniform Alpha Code designations to determine the company name.

Shown below is a list of those firms having the greatest number of yards affected by the noise study levels and, therefore, the largest estimated cost burden to quiet their yards. The listing shown is composed of the most heavily impacted railroad firms by L_{dn} study level.

STUDY LEVELS

L_{dn} 75	L_{dn} 70	L_{dn} 65	L_{dn} 60
CONRAIL	CONRAIL	CONRAIL	CONRAIL
SOU	BN	BN	BN
BN	NW	NW	NW
SP	BO	BO	BO
NW	CNWT	SP	SP
BO			

TABLE 7-15

CLASS I & OTHER RAILROAD COMPLIANCE COSTS FOR STUDY LEVEL 1 (L_{dn} 75)

	1*	2*	3	4 **	5
EASTERN	238	EJE	4	591.5	139.6
	308	GTW	12	596.0	156.7
	354	ITC	4	202.0	51.6
	436	LI	2	665.5	143.5
	550	NW	77	1417.5	537.4
	456	MEC	3	199.2	52.1
	626	PLE	4	572.0	138.3
	663	RFP	3	328.0	74.9
		CR	223	5707.3	2144.6
	839	WM	7	690.5	170.4
	120	CV	2	196.0	48.8
	105	CP	1	193.0	42.9
	129	CEI	7	221.0	65.8
	125	CO	51	1340.5	433.0
	195	DH	9	587.0	151.6
	208	DTI	4	681.5	158.1
	205	DTS	1	302.5	66.3
	56	BAR	3	236.3	54.9
	69	BM	8	703.5	179.0
	61	BLE	4	562.0	125.6
	50	BO	67	1667.5	583.4
SOUTHERN	724	SOU	38	1290.5	443.5
	712	SCL	41	1051.5	434.0
	444	LN	32	1084.0	363.6
	350	ICG	51	1151.0	412.7
	299	GA	1	193.0	48.3
	263	FEC	3	564.5	127.6
WESTERN	216	DWP	0	190.0	41.5
	268	FWD	5	565.0	130.6
	400	KCS	8	594.0	158.3
	490	MKT	13	614.5	170.5
	482	SOO	20	642.2	193.4
	494	MP	37	1010.8	369.9
	559	NWP	1	193.0	48.3
	694	SSW	11	702.5	176.0
	721	SP	37	2006.2	620.9
	693	SLSF	19	807.0	259.3
	802	UP	35	1592.2	457.3
	769	TPW	1	193.0	48.3
	762	TM	2	196.1	46.2
	840	WP	5	575.0	144.2
	22	ATSF	58	1627.2	518.4
	197	DRGW	4	691.5	177.0
	213	DMIR	3	559.0	126.9
	157	CS	2	556.0	128.2
	105	RI	29	936.0	322.1
	160	MILW	50	1096.4	412.5
	131	CNW	63	979.3	409.0
	76	BN	99	2621.7	873.1
	CLASS 1		1160	41943.5	13300.5
	OTHERS		116	8876.5	2709.0

Legend:

1-ACI Code
2-Uniform Alpha Code
3-No. of Yards Quieted
4-Capital Cost ($000)
5-Annualized Cost ($000)

* A listing of railroad names by ACI code and Uniform Alpha Code is given in Appendix F.

** 1976 dollar, a discount rate of 10% per year is assumed.

TABLE 7-16

CLASS I & OTHER RILAROAD COMPLIANCE COSTS FOR STUDY LEVEL 2 (L_{dn} 70)

	1*	2*	3	4**	5
EASTERN	238	EJE	8	696.5	165.1
	308	GTW	23	629.0	172.1
	354	ITC	6	208.0	54.4
	436	LI	4	674.5	147.7
	550	NW	131	1870.5	678.3
	456	MEC	5	205.2	54.9
	626	PLE	11	593.0	148.1
	663	RFP	3	424.0	96.2
		CR	522	7330.3	2737.5
	839	WM	8	696.5	173.2
	120	CV	5	205.0	53.0
	105	CP	1	193.0	42.9
	129	CEI	10	230.0	70.0
	125	CO	81	1445.5	482.0
	195	DH	20	620.0	167.0
	208	DTI	10	702.5	167.9
	205	DTS	2	308.5	69.1
	56	BAR	5	242.3	57.7
	69	BM	24	754.5	202.8
	61	BLE	6	568.0	128.4
	50	BO	118	1841.5	664.6
SOUTHERN	724	SOU	86	1818.5	595.9
	712	SCL	129	1414.5	579.9
	444	LN	86	1348.0	463.3
	350	ICG	99	1397.0	504.0
	299	GA	2	196.0	49.7
	263	FEC	6	573.5	131.8
WESTERN	216	DWP	1	193.0	42.9
	268	FWD	5	565.0	130.6
	400	KCS	16	618.0	169.5
	490	MKT	16	623.5	174.7
	482	SOO	31	675.2	208.8
	494	MP	67	1289.8	453.1
	559	NWP	2	196.0	49.7
	694	SSW	12	708.5	178.8
	721	SP	95	2384.2	750.3
	693	SLSF	38	960.0	307.2
	802	UP	66	1787.2	524.8
	769	TPW	2	196.0	49.7
	762	TM	2	196.1	46.2
	840	WP	11	593.0	152.6
	22	ATSF	95	1930.2	612.8
	197	DRGW	10	712.5	186.0
	213	DMIR	7	571.0	132.5
	157	CS	6	560.0	133.0
	145	RI	63	1044.0	372.5
	140	MILW	92	1321.4	494.0
	131	CNW	115	1130.3	483.2
	76	BN	104	2086.7	1043.1
	CLASS 1		2347	40543.5	15555.3
	OTHERS		351	8820.5	3257.0

Legend:

1-ACI Code
2-Uniform Alpha Code
3-No. of Yards Quieted
4-Capital Cost ($000)
5- Annualized Cost ($000)

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* A listing of railroad names by ACI Code and Uniform Alpha Code is given in Appendix F.

** 1978 dollar, a discount rate of 10% per year is assumed.

TABLE 7-17

CLASS I & OTHER RAILROAD COMPLIANCE COSTS FOR STUDY LEVEL 3 (L_{dn} 65)

	1*	2*	3	4**	5
EASTERN	238	EJE	13	2560.9	1231.3
	308	GTW	24	5695.9	3185.5
	354	ITC	6	1529.8	949.8
	436	LI	4	1657.7	663.8
	550	NW	180	31443.8	19314.0
	456	MEC	8	1306.7	781.5
	626	PLE	16	3016.3	1401.5
	663	RFP	4	1288.9	688.6
		CR	789	125590.7	66837.2
	839	WM	22	2560.9	1692.7
	120	CV	6	1306.5	636.2
	105	CP	1	413.3	234.8
	129	CEI	13	2433.0	1628.1
	125	CO	113	19799.8	12454.8
	195	DH	23	5026.0	2620.1
	208	DTI	13	3007.5	1346.5
	205	DTS	2	851.1	329.4
	56	BAR	6	1343.8	768.9
	69	BM	26	6143.7	2780.3
	61	BLE	6	1889.8	1023.8
	50	BO	181	28550.9	17297.4
SOUTHERN	724	SOU	144	21580.3	11437.9
	712	SCL	180	30139.2	14477.2
	444	LN	111	20701.8	10265.2
	350	ICG	132	23614.7	13630.2
	299	GA	7	636.6	344.0
	263	FEC	9	1895.3	922.3
WESTERN	216	DWP	1	413.3	106.8
	268	FWD	10	1666.5	1128.6
	400	KCS	28	4142.8	2308.3
	490	MKT	33	4148.3	2992.0
	482	SOO	44	7504.5	4849.8
	494	MP	135	16355.9	10007.4
	559	NWP	7	636.6	344.0
	694	SSW	22	3454.1	2435.1
	721	SP	211	24128.7	12486.0
	693	SLSF	76	9535.4	5469.0
	802	UP	136	16734.9	9779.1
	769	TPW	7	636.6	344.0
	762	TM	3	636.7	437.7
	840	WP	21	3016.3	1572.5
	22	ATSF	173	23266.7	14725.9
	197	DRGW	30	3017.5	1496.3
	213	DMIR	9	2113.1	979.2
	157	CS	12	1889.8	819.4
	145	FI	103	15126.9	8427.1
	140	MILW	145	21895.0	13194.4
	131	CNW	156	26574.8	16200.5
	76	BN	297	44641.9	26387.8
	CLASS 1		3696	577519.6	325433.2
	OTHERS		563	87265.9	41905.8

Legend:

1-ACI Code
2-Uniform Alpha Code
3-No. of Yards Quieted
4-Capital Cost ($000)
5-Annualized Cost ($000)

* A listing of railroad names by ACI Code and Uniform Alpha Code is given in Appendix F.

** 1976 dollar, a discount rate of 10% per year is assumed.

TABLE 7-18

CLASS I & OTHER RAILROAD COMPLIANCE COSTS FOR STUDY LEVEL 4 (L_{dn} 60)

	1*	2*	3	4**	5
EASTERN	238	EJE	13	4531.1	2005.3
	308	GTW	24	5695.9	3185.5
	354	ITC	6	1529.8	949.8
	436	LI	4	3627.9	1437.8
	550	NW	180	45235.2	24732.0
	456	MEC	8	1306.7	781.5
	626	PLE	16	3016.3	1401.5
	663	RFP	4	5229.3	2236.6
		CR	789	188637.2	91605.1
	839	WM	22	4531.1	2466.7
	120	CV	6	1306.5	636.2
	105	CP	1	413.3	234.8
	129	CEI	13	2433.0	1628.1
	125	CO	113	29650.8	16324.8
	195	DH	23	5026.0	2620.1
	208	DTI	13	4977.7	2120.5
	205	DTS	2	2821.3	1103.4
	56	BAR	6	1343.8	768.9
	69	BM	26	8113.9	3554.3
	61	BLE	6	1889.8	1023.8
	50	BO	181	42342.3	22715.4
SOUTHERN	724	SOU	144	37341.9	17629.9
	712	SCL	180	36049.8	16799.2
	444	LN	111	28582.6	13361.2
	350	ICG	132	31495.5	16726.2
	299	GA	7	636.6	344.0
	263	FEC	9	1895.3	922.3
WESTERN	216	DWP	1	413.3	106.8
	268	FWD	10	1666.5	1128.6
	400	KCS	28	4142.8	2308.3
	490	MKT	33	4148.3	2992.0
	482	SOO	44	7504.5	4849.8
	494	MP	135	22266.5	12329.4
	559	NWP	7	636.6	344.0
	694	SSW	22	5424.3	3209.1
	721	SP	211	39890.3	18678.0
	693	SLSF	76	13475.8	7017.0
	802	UP	136	24615.7	12875.1
	769	TPW	7	636.6	344.0
	762	TM	3	636.7	437.7
	840	WP	21	3016.3	1572.5
	22	ATSF	173	31147.5	17821.9
	197	DRGW	30	4987.7	2270.3
	213	DMIR	9	2113.1	979.2
	157	CS	12	1889.8	819.4
	145	RI	103	19067.3	9975.1
	140	MILW	145	27805.6	15516.4
	131	CNW	154	28545.0	16974.5
	76	BN	297	64343.9	34127.8
	CLASS 1		3696	808032.7	415931.1
	OTHERS		503	100936.7	50619.8

Legend:

1-ACI Code
2-Uniform Alpha Code
3-No. of Yards Quieted
4-Capital Cost ($000)
5-Annualized Cost ($000)

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* A listing of railroad names by ACI Code and Uniform Alpha Code is given in Appendix F.

** 1976 dollar, a discount rate of 10% per year is assumed.

ECONOMIC IMPACT ANALYSIS

Introduction

The preceding discussion developed the basic information required to perform the economic impact analysis on the railroad industry and individual railroad companies that is detailed in this presentation. The material that follows describes: a) the effects on the industry resulting from the compliance expenditures estimated as necessary to achieve various noise abatement regulatory levels; b) the financial analysis of major and other roads, that uses various measures to assess an individual company's ability to meet the various regulatory levels; and c) a further elaboration of the economic impact on major and other roads resulting from compliance with various noise source abatement regulatory study levels.

Factors Affecting Railroads

As shown in the table below there are considerable differences in cost to achieve the specified study levels of noise abatement. Also, there is a considerable difference in cost depending on whether noise abatement techniques are employed or whether adjacent land is acquired to extend railroad property lines (if and where land purchase is physically possible).

The costs of compliance are shown in the following table. Table 7-19 presents for each regulatory study level, the costs of noise control through the use of abatement procedures, and the costs of acquiring land beyond rail yard property to achieve the various noise levels.

These estimates represent national aggregates, based on typical yard situations. In general, the railroad industry could be expected to choose noise abatement techniques in lieu of land acquisition, because of lower costs. In some cases, however due to local circumstances, land acquisition may be less costly. As presented in this section, costs

TABLE 7-19

ESTIMATED COSTS OF NOISE CONTROL AT DIFFERENT REGULATORY LEVELS

Study Level L_{dn}	By Noise Source Control (Millions of Dollars)		By Land Acquisition (Millions of Dollars)	
	Capital	Annualized	Capital	Annualized
75	37.8	9.8	1,880.0	310.0
70	49.8	16.8	25,830.0	4,210.0
65	639.0	355.0	239,100.0	38,970.0
60	883.3	451.0	564,940.0	92,080.0
70/65*	311.9	165.5	211,830.0	34,530.0

* Denotes study level consists of L_{dn} 70 for compatible land which includes industrial and agricultural land use categories and L_{dn} 65 for non-compatible land which includes residential and commercial land use categories. Undeveloped land is excluded from consideration for this study level.

have been estimated for combining land acquisition with noise source control. The incremental cost of achieving specific noise levels with land acquisition after using noise source control, far exceeds the costs of using noise source control technology alone. In an assessment of the overall impact the more reasonable assumption would be that the railroad industry, in general, would implement the least-cost approach, (i.e., noise source abatement procedures) rather than the purchase of adjoining land at a much higher cost. The economic impact analysis, therefore, is based on cost of noise source abatement.

The financial impact on railroads would involve two basic considerations: 1) the need to raise capital for the purchase and installation of the equipment, and 2) the need to cover with increased revenues the related additional recurring expenses required to meet the noise standard.

The Need For Capital

As shown in Table 7-19, the costs of employing noise abatement procedures rises sharply between study levels 2 and 3. Assuming a regulatory level set at 70 L_{dn}, the added capital requirement of about $50 million would not be particularly significant when compared to the railroads industry's normal capital spending. Capital expenditures by Class I line-haul railroads amounted to $1.7 and $2.2 billion in 1976 and 1977, respectively. In addition to the capital expenditures made by railroad companies, an additional $0.7 billion in railroad investments was made by related industries, raising total railroad capital spending in 1977 to $2.9 billion.

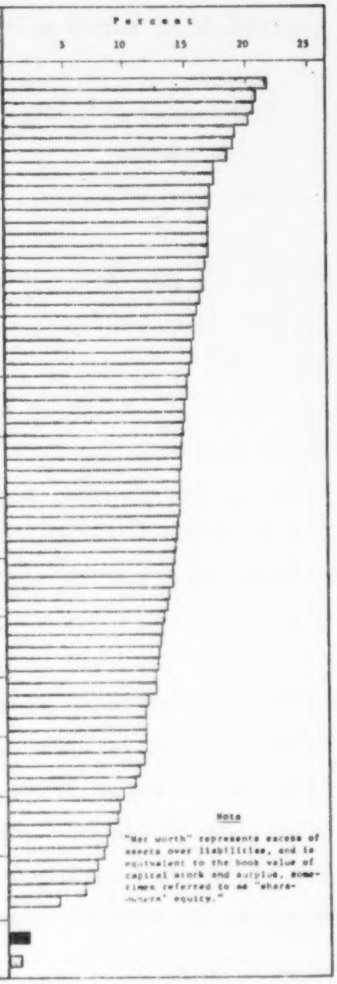
Timing is also a consideration. It is unlikely that the capital spending on installations associated with noise abatement would all be made in a single year. The compliance period for the regulation is envisioned to take place over a 4-6 year period. The added capital expenditures therefore could be scheduled over a four-year period, thereby amounting to an average of approximately $12.5 million per year. This additional capital expenditure of $12.5 million per year would add less than one-half of one percent to the levels currently

TABLE 7-20

RATE OF RETURN ON NET WORTH–LEADING CORPORATIONS

Calendar Year 1976

	Industrial group	Percent return on net worth
1.	Soft drinks	21.8
2.	Soap, cosmetics	20.9
3.	Other mining, quarrying	20.8
4.	Drugs and medicines	20.6
5.	Construction	19.2
6.	Shipping and other transportation	19.1
7.	Autos and trucks	18.6
8.	Household appliances	17.5
9.	Restaurants and hotels	17.5
10.	Glass products	17.2
11.	Farm, construction, material-handling eqpt.	17.2
12.	Electrical equipment and electronics	17.1
13.	TOTAL MINING	17.1
14.	TOTAL SERVICES	17.1
15.	Tobacco products	17.1
16.	Other food products	16.8
17.	Variety chains	16.7
18.	Office equipment, computers	16.7
19.	Other business services	16.4
20.	Hardware and tools	16.1
21.	Baking	15.9
22.	Wholesale and miscellaneous retail	15.9
23.	Chemical products	15.7
24.	Metal mining	15.7
25.	Lumber and wood products	15.6
26.	Miscellaneous finance	15.4
27.	Instruments, photo goods, etc.	15.4
28.	Automotive parts	15.1
29.	Petroleum production and refining	15.1
30.	TOTAL MANUFACTURING	15.0
31.	Printing and publishing	14.9
32.	Common carrier trucking	14.8
33.	Building, heating, plumbing equipment	14.8
34.	TOTAL TRADE	14.7
35.	Shoes, leather, etc.	14.7
36.	Other metal products	14.7
37.	Paper and allied products	14.7
38.	Amusements	14.6
39.	Other machinery	14.5
40.	Department and specialty	14.4
41.	Dairy products	14.3
42.	TOTAL NONFINANCIAL	14.0
43.	Distilling	14.0
44.	Miscellaneous manufacturing	13.8
45.	Aerospace	13.7
46.	GRAND TOTAL	13.3
47.	Mail order	13.2
48.	Air transport	13.1
49.	Food chains	12.9
50.	Meat packing	12.8
51.	Clothing and apparel	12.6
52.	Brewing	12.6
53.	Sales finance	12.0
54.	Electric power and gas	11.8
55.	Property and liability insurance	11.8
56.	Commercial banks and holding companies	11.8
57.	TOTAL PUBLIC UTILITIES	11.8
58.	Telephone and communications	11.6
59.	Other stone and clay products	11.1
60.	Furniture and fixtures	10.9
61.	Paint and allied products	9.8
62.	Cement	9.5
63.	TOTAL FINANCIAL	9.4
64.	Nonferrous metals	8.7
65.	Iron and steel	8.4
66.	Textile products	8.2
67.	Sugar	7.8
68.	Rubber and allied products	7.4
69.	TOTAL TRANSPORTATION	6.7
70.	Investment funds	6.4
71.	**CLASS I RAILROADS**	1.8
72.	Real estate	1.2



Note

"Net worth" represents excess of assets over liabilities, and is equivalent to the book value of capital stock and surplus, sometimes referred to as "shareowners' equity."

Source: Citibank (formerly First National City Bank of New York), Monthly Economic Letter, April 1977.

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being spent by the railroad industry. It is estimated that achieving the 65 L_{dn} level would result in a more significant capital requirement of $639 million. Spread over a four-year period, the annual requirement would amount to about 6 percent of average industry capital spending.

Although the added burden at the L_{dn} 70 level and perhaps the L_{dn} 65 level, appears to be of modest proportions, it must be recognized that certain railroads are in financial difficulty. Firms typically obtain capital from three sources:

- Internally from retained earnings
- by borrowing in the capital markets (notes and bonds)
- from equity issues.

Considering the railroad industry's general financial condition, it may be difficult to raise capital in any of those ways. There are some exceptions, of course. Some railroads are financially healthy and would have little difficulty raising capital, either internally or externally. However, the majority are not very profitable, and CONRAIL requires direct government support to remain operational. A detailed discussion of CONRAIL is presented in Appendix J. There are enough poorly performing firms to bring the average condition down to a relatively low level.

In 1977, the railroad industry's return of investment was 1.3 percent which is low in both absolute and relative terms. Table 7-20 illustrates the relative profitability of railroads when compared with other industries, based on stockholders' equity. This low rate is indicative of low net earnings which on the average makes internal financing of large capital requirements very difficult.

The relative unprofitability of the railroad industry also adversely affects the terms of debt financing of fixed assets on which the return is low and risks are high for marginal firms. The railroad industry is in a relatively poor position to compete for capital funds. As Table 7-20 shows, among 72 industries, railroads are next to last in profitability relative to equity or net worth.

The purpose to which companies intend to use financing also weighs heavily on decisions to lend. Capital to upgrade equipment to improve earnings is more likely to be made available at reasonable costs than if its purpose is non-productive fixed plant. Unfortunately, investments in noise abatement devices would not improve earnings and the profitability of the industry, and therefore would be relatively more difficult to finance.

Operating Expenses

In addition to the industry's problem of raising the capital needed for a noise abatement program, there is the related burden from the increased operating expenses of railroads. The resulting cost increases will be in terms of the added capital recovery requirements and the new operating and maintenance expenses of the needed noise abatement procedures and equipment. The effect that these increases will have on railroad markets is an important consideration. Of concern is the extent to which freight rates would have to be raised to recover the increased costs and the effect that higher rates would have on the volume of shipments and revenues. The subsequent analysis provides estimates of anticipated changes that might result from complying with a noise standard in terms of relative increases in prices, decreases in demand, and changes in the employment levels for the major and other roads examined.

Tax Considerations

Tax considerations could also have a significant impact on the costs of noise abatement. In some cases, taxes would have the effect of reducing costs, and in some cases, taxes would increase costs associated with noise abatement. Since the financial posture of the companies analyzed varied, potential impacts are likely to differ considerably depending upon 1) the techniques adopted by railroad companies, 2) local tax provisions, and 3) each company's financial condition; therefore, no adjustments were made in the costs due to tax considerations.

The Tax Reform Act of 1976 contains a special provision for railroads. Investment tax credits can apply to virtually all of the 1977 and 1978 tax liability for railroad companies. Thereafter, tax preference decreases by 10 percent each year until it reaches the normal level of 50 percent in 1983.

Investment tax credits will reduce investment costs by 10 percent for qualified investments. To qualify, investments must be in equipment (rather than real property) and must have an economic life beyond a certain time period or the credit is reduced. New structures in railroad yards to quiet noise may not qualify.

Unlike a deductible business expense, an investment tax credit can be deducted directly from the amount of tax payable. A railroad company operating in the deficit, however, would be limited in benefitting from such a tax benefit.

Local property taxes are a consideration also. Most local property taxes are based on property valuation. The construction of new structures, for example, would have the effect of increasing the value of the railroad property and, therefore, the property tax that must be paid. Such an increase in property taxes would increase the annual expenses associated with noise abatement.

Increases in operating costs due to noise control also can have a tax effect. If increased operating costs reduce profits, the loss would be reduced to some extent through the consequent reduction in corporate tax payments.

To conclude this discussion, there are a number of tax considerations that would probably have the effect of reducing the costs associated with noise control. However, some number of these could have the opposite effect of increasing the tax burden. The overall effects would vary depending upon the particular railroad, its noise problems, feasible methods of abatement, and the company's financial position.

Accounting Considerations

For track and road bed expenditures, railroad companies utilize betterment accounting in contrast to general accepted accounting procedures)GAAP). This method of accounting may possibly be used for certain noise abatement expenditures such as retarder barriers and releasable retarders.

Betterment accounting treats maintenance, repair and renewal outlays for track and road beds as operating expenses when they are incurred. If treated in this manner, capital recovery expenses for the items affected would have to be treated differently. They would have to be shown as expenses incurred for specific time periods which was not conducted in this study.

The portion of the expense that represents an improvement would be capitalized in accordance with betterment accounting practices. At this time it is uncertain as to whether such expenditures would be interpreted as improvements in terms of noise abatement, or whether the installation of noise abatement techniques would be viewed as track and road bed expenditures.

Availability of Necessary Noise Abatement Materials and Equipment

It is highly unlikely that the employment of railroad noise abatement techniques would be impeded by any material shortages. For the types of materials that are involved, the amounts that would be required represent only a small portion of the quantities currently being produced in the United States.

A variety of materials would be required for installing the noise abatement equipment. The major materials needed for noise barriers for retarders are sound absorptive materials, panels and metal mesh to hold the acoustical material to the panels. Master retarders are 150 feet in length, on the average. Group retarders average about 100 feet in length. Assuming that noise barriers would be installed 10 feet high on both sides of the retarders in all 124 hump classification yards, there would be a requirement for 1,860,000 square feet of barriers. Barriers involving this amount of square footage results in a need for equal amounts of acoustical materials, panels and mesh.

Acoustical fiberglass could be used as the sound absorptive material. Production statistics for insulation type fiberglass are usually expressed in weight. A square foot of acoustical type fiberglass weighs approximately one half pound. A requirement for 1,860,000 square feet of fiberglass for the barriers would result in a requirement of 930,000 pounds of fiberglass.

The compliance period presently under consideration is approximately four years. The requirements for materials should also span that four year period. As a consequence, approximately one-fourth of the necessary materials would be required each year of the compliance period. The annual requirement for acoustical fiberglass therefore, would be one-fourth of 930,000 or approximately 233,000 pounds for each of the four years.

The annual production of fiberglass insulating materials is approximately 2 billion[4] pounds. The requirement, therefore, only represents .0014 of the nation's annual production.

Outdoor plywood panels can be used as barrier panels. The same square footage requirement would apply to panels, i.e., 1,860,000 square feet. Inasmuch as this amount would also be spread over a four year period, the annual requirement would be for 466,000 square feet of panel. Annual production of exterior softwood plywood in the United States is approximately 13 billion square feet. The barrier requirement, therefore, is an extremely small fraction of national production.

There would be a similar requirement of 1,860,000 square feet of wire mesh to hold the acoustical material. The national production of similar materials, used for a variety of applications, but primarily fencing, is currently approximately 3.4 billion square feet annually.[5] Spread over a four year compliance period, the noise barrier requirement would equal 466,000 square feet. Once agian, only a very small fraction of the national output would be involved in the requirement for railroad yard noise control.

Another significant requirement for noise abatement is the construction that would be required to abate noise emanating from load test sites. The railroad yard noise abatement requirement is for $19.6 million of industrial type construction. This requirement would also be spread over a four year period, and therefore amount to $4.9 million per year for the four year compliance period under consideration. Approximately $8 billion[5] in expenditures for industrial building construction are made annually. The load test site requirement would only represent .0006 of the industrial construction now being carried out annually.

- The installation of improved mufflers also represents a significant requirement for railroad noise abatement. The number of switch engine mufflers involved is approxiamtely 6500. An added number of refrigerator car mufflers is approximately 26,000. The requirement for improved mufflers of both types totals approximately 32,500 mufflers. Over a four year period, the requirements would involve 8,125 mufflers annually.

Annual muffler production data are not available. However, solely on the basis of vehicle production quantities and inventories, and not considering stationary engines, muffler production of all types would exceed 50 million units annually including replacements. An affected quantity of approximately 8,125, therefore, would represent an extremely small portion of total U.S. muffler production.

Regulatory Considerations

Because interstate carriers are regulated, the ICC's role must be taken into consideration in matters relating to any rate adjustment that would result from additional costs related to noise abatement. The

ICC must approve rate changes for interstate carriers. Some flexibility in pricing policy has been given to railroads by Section 202 of the Railroad Revitalization and Regulatory Reform Act of 1976. Under this legislation, railroads may now, under certain conditions, alter rates up to seven percent. However, there is the problem as to whether this provision is being effectively utilized.

Although many factors enter into rate-making decisions, cost is one of the more important considerations, along with value-of-service. The consideration of value-of-service has been important in the past in determining relative rates such as for the higher unit-value manufactured products in comparison to lower unit-value raw materials. However, cost is a more important consideration at the aggregate level. The ICC, in conducting its carrier rate-monitoring functions, collects extensive data on railroad costs which are used as yardsticks for evaluating the merit of proposed rate increases. The total revenues obtained on the basis of the rate structure must cover industry costs in the long run and should cover all variable costs in the short-term.

Since noise abatement will increase costs, the railroads can be expected to apply for general rate increases to cover those costs. To be granted a modest rate increase to comply with a government regulation for noise control should not be difficult. Industry sources concede that carriers generally have had success in obtaining most of the increases they have proposed. However, in a competitive sense, general rate increases are relatively risky, since the risk is variable across transportation markets and higher for some.[6]

As to the regulatory lag which has been mentioned as a problem, under Section 206 of the ICC Act, a notice of intention to file for a new rate due to an anticipated capital investment can be used to speed up the process.

In summary, there should be little difficulty in securing from ICC the related rate increases to cover increases in costs, provided they are relatively small.

Employment

The added financial burden resulting from the cost of abating railroad yard noise will have impacts on rates, volume of business, and therefore, employment. There are currently about 485,000 employees in railroad companies. The impact on employment was calculated for individual companies for the discussion on individual railroads which appears later in this section.

Impacts were calculated for the two measures of the price elasticity of demand for rail transportation constituting the range of elasticities for commodity shipments. Also, impacts were calculated for the regulatory levels: L_{dn} 70 and L_{dn} 65. From these calculations, estimates were made of the impact on employment for the entire railroad industry. The results appear in Table 7-21 below.

TABLE 7-21

CHANGES IN EMPLOYMENT ASSOCIATED WITH VARYING REGULATORY LEVELS AND VARYING ELASTICITIES

Regulatory Levels	L_{dn} 70		L_{dn} 65	
Elasticity of Demand	-.39	-1.41	-.39	-1.41
Percentage Decrease in Employment	0.03	0.13	0.66	3.22
Decreases in Railroad Employment	146	631	3201	15,617

Indirect Employment Effects

The employment effects which have been calculated and presented previously would be the direct effects on railroad company employment. There would also be indirect employment effects, impacting primarily on the suppliers of noise abatement equipment and facilities. Labor will be required to manufacture the necessary mufflers, ductile iron shoes, releasable retarders, noise barriers, and so on, for all of the items necessary for railroad yard noise control.

Quieting load test sites would require additional construction workers to build structures to enclose locomotives during load test operations. It is estimated that 216 such structures would be required, and the total cost of constructing the structures would be approximately $20 million. Applying the average worker/industrial construction ratio of $35,000* for workers indicates that 575 construction worker man-years would be required for the construction. The need to construct structures for load test sites, therefore, results in an indirect employment effect amounting to 575 man-years of construction labor.

A number of the noise control techniques selected for consideration employ fabricated metal. These techniques include modified parts for locomotives and refrigerator units, ductile iron shoes and releasable retarders. Depending on the noise abatement level under consideration, the cost of such fabricated metal parts could equal approximately $72 million. The worker/output ratio in the fabricated metals industry is one worker per $160,000 value of output.** Therefore, product shipments valued at $72 million implies an employment of 450 worker man-years.

The construction and erection of retarder barriers are estimated to cost approximately $14 million. Industry categorization does not show any industry as specialized in this type of construction. For making labor estimates, however, industrial type construction could be considered analogous.

As shown above the employee/output ratio for industrial construction is $35,000 per employee. This implies that a requirement for $14 million in barrier construction would require 400 man-years of construction workers.

Summing the above implied indirect labor effects on supplier industries therefore, is as follows:

Enclosure Construction	575 man-years
Fabricated Metals	450 man-years
Barrier Construction	400 man-years
Total	1425 man-years

Fuel Consumption

In 1976, railroads consumed approximately four million gallons of diesel fuel. Over 99 percent of railroad locomotives are diesel-electric units, and thus, virtually all of the fuel consumed in railroad operations is diesel fuel.

The rail yard noise control reguation has two opposing effects on fuel consumption. The first effect pertains to the anticipated decrease in industry-wide freight services (revenue ton-miles) as the result of higher freight rates, thus decreasing fuel demand by about 38 million gallons of fuel per annum. The second effect increases consumption, inasmuch as the new muffler to be installed on the switch engines will consume one to one and one-half percent more fuel than without such a technological fix. Other EPA noise control standards will have already required the line haul power to have mufflers installed with an increased fuel consumption of one to one and one-half percent. Therefore, the new yard noise control regulation will not further impact these units. However, this regulation will increase fuel consumption for yard switch engine operations by approximately 800,000 gallons annually.

Balance of Payments

It would be difficult to quantify the effects on the U.S. balance of payments resulting from the noise abatement of railroad yards. The increase in costs would be relatively small when compared with the total operating costs of railroads. Therefore, the impact on the U.S. balance of payments would likewise be fairly low. It can be expected that any action which raises transportation costs and thus the price of American export goods could have an adverse effect on the U.S balance of payments. American exports could become more expensive to foreign buyers and their reaction could be to buy less from U.S. producers by either cutting their consumption or seeking alternative supply sources.

There are certain commodities important to foreign trade revenues that would be affected. U.S. grain and coal are important export commodities and they are also heavily involved in railroad transportation. If raising the price of these commodities to finance noise abatement results in foreign buyers turning to alternative sources, the trade effect would be detrimental. If, however, the price elasticity of demand is inelastic for these commodities abroad, then the added costs could be passed on to foreign buyers without harm to the U.S. balance of payments.

Iron ore and coal used in making steel are also commodities worth considering, but in a different context. If, for example, freight rates for iron ore and coal are raised and, as a result, prices of domestic steel are raised, imports of foreign steel could increase. This would also have a detrimental impact on the U.S. balance of payments.

Financial Impact Analysis of Compliance Costs

Compliance costs can be expected to impact to a greater or lesser degree on different railroad companies depending upon their financial situation. Some railroads are in relatively good financial condition, while others are in financial straits and may have difficulty with the added expense of noise abatement. This presentation attempts to measure the financial condition of individual railroad companies, and the cost impact of noise regulation compliance. The purpose is to provide an indication of the capacity of individual companies to absorb the added costs of noise abatement.

A selection of financial indicators were used as the basis for assessing the financial condition of railroad companies. The impact of compliance costs has been measured at two levels; L_{dn} 70 and L_{dn} 65. The measures that were selected include liquidity, profitability and efficiency measures. The measures are outlined as follows:

1) The extent to which revenues cover expenses -
   (ratio: net operating revenues/gross revenues)
2) The return on capital -
   (ratio: net operating revenues/total assets)
3) The extent to which assets are used to generate revenues -
   (ratio: gross revenues/total assets)
4) The ability to meet current expenses -
   (ratio: current assets/current liabilities)
5) The relationship of total assets to total liabilities -
   (ratio: current assets/total liabilities).

The measures have been taken from the literature of financial assessment of railroads. Four of the five have been described as "price picks" in terms of their ability to assess the financial condition of railroads.[7]

Another ratio (current assets to current liabilities) was included in order to measure the liquidity position of railroads and this appears relevant from the standpoint of measuring a firm's condition to finance noise abatement techniques.

Some caution should be exercised in the strict interpretation of these ratios. This is primarily because the analyses is addressed to a single year. Abnormal conditions (financial or operational) could be different when reviewed from a longer time span.

Another important cautionary note concerns the validity of using financial ratios. The use of ratios as financial indicators is not universally accepted. There is an opposing view that the financial condition of a firm can only be assessed with a detailed examination of that firms' finances and its organizational arrangements. According to this view, ratios can be misleading because of differences in the manner in which firms treat the variables involved, such as asset valuation or current expenses. Nevertheless, because it was not possible to conduct detailed analyses of the companies with the scope of this study, ratios were developed and are presented here with the understanding that they should not be viewed as conclusive. This is particularly true for the tables appearing below that present the top and bottom five companies for each ratio because abnormalities are more likely to appear in the extreme cases. It should be noted, however, that firms that are repeatedly in good financial condition tend to appear in the upper sets, while those that are repeatedly in financial difficulty tend to appear in the lower sets.

A longer time span could lead to different results. For example, a recently published ICC study[b], indicates that a five year span (1972-76) indicated that seven carriers had deficit returns on investments for at least three of the five years. The carriers included the Grand Trunk Wester, Canadian Pacific in Main, Long Island, Boston and Maine, Rock Island, Milwaukee and Missouri-Kansas-Texas. These differ from the carriers shown in the tables below of one-year ratios. Time constraints prevented the use of a longer time span in this study. Also, the basic purpose of the indicators for this study is different. The purpose here is to gauge the effects of added noise abatement expenses, rather than to assess the general financial conditions of the companies. A one year span should be sufficient for this purpose.

Contributing to the selection of ratios was the consideration of the availability of data. The measures had to be adapted to the types of data which are also available for Class II railroads. ICC requirements usually ensure sufficient data for Class I carriers. Nevertheless, one Class I and a number of Class II railroads had to be omitted from the analysis because their financial data were not available.

The complete list of railroads and their financial rates appear in Appendix G. Listed below for Class I railroads are the top and bottom five, to indicate those that are in relatively better financial condition, in contrast to those that are in worse financial conditions on a relative basis. In addition, the impacts of compliance costs are calculated in the ratios for two noise abatement levels (L_{dn} 70 and L_{dn} 65).

It should be noted that the impacts measured here apply solely to compliance costs. The impacts from secondary effects, such as increases in freight rates, changes in traffic and revenues are considered elsewhere in this section.

The ratio values for Class I carriers are presented in three columns. The first column contains the ratio prior to noise regulation, the second reflects the cost to the railroad to comply with a regulation of L_{dn} 70 and the third column reflects the cost to the railroad to comply with a more stringent regulation of L_{dn} 65.

It is significant to note from the ratios, and from the extent to which ratios change due to compliance costs, that the financial condition of railroads would be altered only to a minor degree by the imposition of noise control regulations.

1. Ratio: Net Operating Revenue/Gross Revenue.

Company (Top five)	Current (before Reg.)	L_{dn} 70	L_{dn} 65
Duluth, Winnipeg & Pacific	0.75	0.75	0.74
Richmond, Fredericksburg, and Potomac	0.41	0.41	0.40
Norfolk and Western	0.32	0.32	0.30
Soo Line	0.31	0.31	0.29
Missouri Pacific	0.28	0.28	0.27
(Bottom five)			
Long Island RR Co.	-0.72	-0.72	-0.73
Chicago, Milwaukee, St. Paul & Pacific	-0.02	-0.02	-0.02
Bangor & Aroostook	0.04	0.04	0.01
Canadian Pacific	0.04	0.04	0.04
Central Vermont RR Co.	0.06	0.06	0.01

2. Ratio: Net Operating Revenues/Total Assets

Company (Top five)	Current (before Reg.)	L_{dn} 70	L_{dn} 65
Duluth, Winnipeg & Pacific	0.55	0.55	0.54
Toledo, Peoria & Western	0.32	0.32	0.30
Chicago & Northwestern	0.20	0.20	0.17
Elgin, Joliet & Eastern	0.20	0.20	0.19
Detroit & Toledo Shoreline	0.17	0.17	0.15
(Bottom five)			
Chicago, Milwaukee, St. Paul & Pacific	-0.01	-0.01	-0.03
Pittsburgh & Lake Erie	0.01	0.01	0.01
Bangor & Aroostook	0.01	0.01	0.00
Central Vermont	0.02	0.02	0.00
Maine Central	0.05	0.05	0.04

3. Ratio: Gross Revenues/Total Assets

Company (Top five)	Current (before Reg.)	L_{dn} 70	L_{dn} 65
Toledo, Peoria & Western	1.17	1.16	1.13
Chicago & Northwestern	1.00	1.00	0.96
Chicago, Rock Island & Pacific	0.78	0.78	0.76
Elgin, Joliet & Eastern	0.77	0.77	0.76
Duluth, Winnipeg & Pacific	0.74	0.74	0.73
(Bottom five)			
Pittsburgh & Lake Erie	0.21	0.21	0.21
Richmond, Fredericksburg Potomac	0.28	0.28	0.27
Colorado & Southern	0.30	0.30	0.29
Bangor & Aroostook	0.31	0.31	0.30
St. Louis Southwestern	0.35	0.35	0.35

4. Ratio: Current Assets/Current Liabilities

Company	Current (before Reg.)	L_{dn} 70	L_{dn} 65
(Top five)			
Texas Mexican	3.39	3.33	2.86
Florida East Coast	2.80	2.77	2.57
Western Maryland	2.55	2.53	2.38
St. Louis Southwestern	2.38	2.37	2.27
Richmond, Fredericksburg & Potomac	2.25	2.24	2.14
(Bottom five)			
Union Pacific	0.74	0.74	0.72
Fort Worth & Denver	0.80	0.79	0.75
Missouri-Kansas-Texas	0.81	0.80	0.73
Long Island	0.85	0.85	0.83
Georgia	0.85	0.85	0.80

5. Ratio: Current Assets/Total Liabilities

Company	Current (before Reg.)	L_{dn} 70	L_{dn} 65
(Top five)			
Western Pacific	0.45	0.45	0.44
Texas Mexican	0.39	0.38	0.38
Toledo, Peoria & Western	0.26	0.26	0.25
Western Maryland	0.26	0.26	0.26
Elgin, Joliet & Eastern	0.25	0.25	0.25
(Bottom five)			
Northwestern Pacific	0.06	0.06	0.05
Pittsburgh & Lake Erie	0.07	0.07	0.07
Union Pacific	0.08	0.08	0.08
Bangor & Aroostook	0.09	0.09	0.09
Akron & Barberton Belt	0.10	0.10	0.08

The above tables included only Class I railroads. The ratios were tabulated for all railroads for which there were sufficient data, including Class II railroads. The complete list of railroads and their ratios are presented in Appendix G.

Tabulations of the dispersion of ratio values were made, and appear below. Entries represent the percentage of railroads falling below the column figures.

Dispersion of Financial Ratio Values

1. Net Operating Revenues/Gross Revenues

	Min.	5%	25%	Median	75%	95%	Max.
Current	-8.60	-0.60	0.12	0.22	0.32	0.52	0.83
L_{dn} 70	-8.61	-0.61	0.10	0.21	0.32	0.52	0.82
L_{dn} 65	-9.17	-0.86	0.06	0.18	0.27	0.50	0.82

2. Net Operating Revenues/Total Assets

	Min.	5%	25%	Median	75%	95%	Max.
Current	-0.69	-0.10	0.04	0.11	0.19	0.44	1.23
L_{dn} 70	-0.69	-0.11	0.04	0.11	0.18	0.42	1.18
L_{dn} 65	-0.68	-0.17	0.03	0.12	0.18	0.39	1.16

3. Gross Revenues/Total Assets

	Min.	5%	25%	Median	75%	95%	Max.
Current	*	-0.16	0.37	0.49	0.67	1.15	2.41
L_{dn} 70	*	0.16	0.37	0.49	0.67	1.15	2.39
L_{dn} 65	*	0.15	0.33	0.46	0.64	1.09	2.16

4. Current Assets/Current Liabilties

	Min.	5%	25%	Median	75%	95%	Max.
Current	-1.37	0.36	0.96	1.33	2.16	6.01	23.33
L_{dn} 70	-1.22	0.35	0.95	1.30	2.07	5.34	18.29
L_{dn} 65	-1.17	0.30	0.83	1.11	1.71	4.32	17.39

5. Current Assets/Total Liabilities

	Min.	5%	25%	Median	75%	95%	Max.
Current	-0.16	0.06	0.12	0.21	0.32	0.59	0.94
L_{dn} 70	-0.14	0.06	0.12	0.21	0.32	0.58	0.85
L_{dn} 65	-.012	0.06	0.12	0.19	0.31	0.50	0.78

The Price Elasticity of Rail Transport Demand.

The price elasticity of demand must be considered in any attempt to quantify the impact of cost increases associated with noise control of the railroad industry. Price elasticity of demand is defined to measure the change in the quantity demanded of a good or service directly associated with a change in the price of that good or service. Estimates of elasticity can be stated in terms of the percentage decrease in demand corresponding to a one percent increase in price. Estimates of -1.0 and below are considered price elastic (i.e., the demand for the good or service is relatively sensitive to price changes), whereas estimates between 0 and -1.0 are considered price inelastic (i.e., demand is relatively less sensitive to price changes).

The elasticity estimates used in this section were drawn from relevant studies by A.T. Kearney, Inc., (1977) and A. Morton (1969), as presented in the ICC report to Congress, entitled The Impact of the 4R Act.[8] The ranges of empirical elasticity estimates for rail transport services associated with particular major commodities are shown in Table 7-22. There are a number of considerations that should apply in the interpretation and use of the elasticity values, which are as follows:

- There are various factors other than price that influence demand for rail transportation. One important factor is quality of service. If the quality of rail service deteriorates in terms of longer transit time due to nighttime curtailment, for example, rail shipments could decrease even though freight rates remain unchanged. Other factors include income levels and increased access to other transportation modes.
- Elasticity values are time sensitive. The values being presented here are for the short term. Usually short term price elasticity estimates are less elastic than long term estimates. There is greater possibility for customer or shipper adjustment to price changes in the longer term.
- Price elasticities are often variable with regard to the level of price and the size of the increase. It is likely, therefore, that no single value can be determined as the price elasticity of demand.
- The price elasticity for a single product can vary according to location, or from route to route, often depending upon intermodal competition.

TABLE 7-22

ESTIMATES OF PRICE ELASTICITIES OF RAIL TRANSPORT DEMAND

Commodity	Range of Estimated Price Elasticities of Demand [a]
Bituminous Coal	-0.128 to -0.38
Iron Ore	-0.39 to -0.819
Aggregate Materials	-0.35 to -4.40
Corn (to represent agric. products)	-0.837 to -1.32
Pulpwood, logs, & chips (timber)	-0.366 to -0.814
Iron & steel mfg. goods	-0.1 to -0.3
Automobiles	-0.76 to -1.68

Source: Table V-3, p. 103, ICC report to Congress on The Impact of the 4R Act, Oct. 1977.

With the exception of some aggregates and auto shipments, Table 7-22 in general indicates relatively inelastic values for the commodities shown. However, the estimated ranges are wide and background data are not all current. These estimates are used in this study for the economic impact analysis. Other sources do not currently offer better estimates.

In the subsequent price and impact analysis, the fourteen separate estimates of the Table 7-22 were reduced to two, representing a low weighted average of -0.39 and a high weighted average of -1.41. This reduction was achieved by weighting the estimates displayed in Table 7-22 by the contribution of each commodity class to total railroad revenue. The process and final estimates are shown in Table 7-23. It is estimated that the listed commodities will account for about 75 percent of railroad revenues in 1985. Some manufactured products finished for retail are characterized by greater price elasticity but comprise less than 20 percent of railroad revenue.

TABLE 7- 23

ESTIMATED RAIL TRANSPORT PRICE ELASTICITIES OF DEMAND FOR EACH MAJOR COMMODITY, WEIGHTED BY ITS SHARE OF RAIL FREIGHT REVENUES

Type of Commodity	Base[a]	Average Share of Major Source RR Revenues[b] (1975+1985)÷2 Percentage	Estimated RR Price Elasticity of Demand For Rail Services[c]		Partial Price Elasticities of Demand Weighted By RR Revenue Shares[d]	
			Low	High	Low	High
Agriculture	(corn)	13.70	-.837	-1.32	-.11	- .18
Iron Ore		3.37	-.39	-0.819	-.01	- .03
Coal		17.98	-.128	-0.38	-.02	- .07
Misc. Mining	(average between iron ore & Aggregates)	8.51	-.37	-2.61	-.03	- .22
Food & Drug	(overall avg. used)	17.60	(overall avg. used)		-.07	- .27
Lumber & Prod.	(pulpwood, logs & chips)	11.05	-.366	-0.814	-.04	- .09
Chemicals	(overall avg. used)	9.51	(overall avg. used)		-.04	- .15
Iron & Steel		5.46	-.1	-0.3	-.01	- .02
Stone Clay Glass	(aggregates)	7.08	-.35	-4.40	-.02	- .31
Motor Vehicles		5.77	-.76	-1.68	wt. -.04	- .07
TOTAL:		100.3 avgs:	-.4126	-1.540	avgs. -.39	-1.41

[a] For a major commodity category, the estimated price elasticity of demand for the commodity in brackets was used wherever information was not available.

[b] These averages of 1975 and 1985 shares contributed to RR revenues were obtained from Exhibit IV-D(21) p. 143 of the study, Intercity Domestic Transportation System for Passengers and Freight (Ref. 1).

[c] These estimates of elasticities are from Table V-3, p. 103, of the ICC report to Congress on The Impact of the 4R Act: Railroad Ratemaking Provisions, Oct. 5, 1977 (Reference 10).

[d] These columns are obtained by multiplying the normalized percentage in the first column by the low or high estimates of teh 2nd and 3rd column.

APPLICATION OF A MICROECONOMIC MODELING TECHNIQUE TO ESTIMATE PRICE INCREASES RESULTING FROM COMPLIANCE WITH POTENTIAL NOISE STANDARDS BY RAIL CARRIERS

The effect of a noise emission standard on the railroad industry is to impose variable financial and economic impacts on firms in the industry. The impact varies from firm to firm since it represents the cost to comply with a noise abatement regulation on railroad property owned and operated by individual firms. To cover the compliance cost imposed by such a regulation, individual railroad firms have but one option to recover such costs directly, assuming they do not absorb the costs through profits and that no Federal subsidy is available. This options is to petition the ICC for a freight rate change which can be expressed as a unit price increase for the commodities the firm transports by rail. The objective of the microeconomic price model is to analyze the size and relative effect of a price increase on each railroad firm which must comply with a noise emission regulation. The model analyzes only the compliance impacts of the imposition of the noise standard and appropriately excludes from consideration the normal dynamics of the industry and transportation markets.

The model assumes that the changes in price and demand are sufficiently small that they can be related by a constant price elasticity of demand. It further assumes that the unit cost of providing services is constant. The model estimates the price increase that has to be introduced for the railroad firm or operator to maintain the net income (i.e., operating revenues less operating expenses) before and after complying with the noise standard. The price increase, p, is given by the smaller root of the quadratic equation:

$$\varepsilon_d\ (\Delta p) + [\varepsilon_d(p-c)+p]\ (\Delta p) - \frac{CC}{q}\, p = 0$$

where ε_d is the price elasticity of demand,

p is the unit price,

c is the unit cost,

q is the production level,

CC is the total compliance cost.

The detailed derivation of this equation and description of the model is given in Appendix H.

The Employment Model

When a rail carrier increases the price of service, demand and output will decrease if the price elasticity of demand is less than zero. Assuming that employment is directly proportional to adjusted revenue (i.e., revenue less compliance cost), a model is constructed to estimate the decrease in employment resulting from a price increase and demand decrease. The detailed description of the model is given in Appendix H.

PRICE DEMAND AND EMPLOYMENT IMPACTS ON INDIVIDUAL RAILROADS

Analyses of the Impacts of Comliance Costs on Prices, Demand for Rail Services, and Employment

Study Level L_{dn} 70 with price elasticity of demand assumed to be -0.39

Using the microeconomic price model the 1976 data[c] for the unit "price", "cost", revenue ton-miles, and the estimated price elasticity of demand, the compliance costs per "ton-mile" of service level for each railroad were analyzed to determine the potential impact of price increases on demand/output, and employment. Sufficient data are available for analyzing most of the Class I railroads and some other railroads. A full listing of the results of the analysis is given in Appendix I.

For the 49 Class I railroads, the expected short-term reaction of shippers to a median increase of about 0.1 percent in railroad rates that would cover compliance costs would lead to an average decrease in demand for rail services of less than 0.05 percent. This decrease would create either an equivalent loss in jobs or underutilize about 119 railroad employees from these firms. For the other firms, the potential employment impact appears negligible. If they were not laid off, labor productivity would decline accordingly. For this study level, on the average, employment would decline about two to three workers per firm. The railroads most heavily impacted are indicated in Table 7-24.

TABLE 7-24

COMPLIANCE IMPACTS FOR THE STUDY LEVELS, L_{dn} 70; ε_d - -0.39

Railroad	Percentage Increase In Price	Percentage Decrease In Demand	Decrease In Employment or No. Workers Idled
	(A - Based on Heaviest Employment Impacts)		
Conrail	0.1	0.0*	29
Burlington Northern	0.1	0.0*	9
Southern Pacific	0.0*	0.0*	7
Atchison, Topeka & Santa Fe	0.0*	0.0*	5
	(B - Based on Largest Price Increases)		
Texas Mexican	0.5	0.2	0
Detroit & Toledo Shoreline	0.5	0.2	0
Central Vermont	0.4	0.2	1

* 0.0 indicates less than 0.05.

Study Level L_{dn} 70 with the price elasticity of demand assumed to be -1.41

For the study level L_{dn} 70, with price elasticity of demand -1.41 those railroads experiencing the greatest price and demand impacts are presented in Table 7-25.

With regard to the greatest impacts on employment, Conrail, would experience about 120 workers underemployed or laid off, Burlington Northern about 39, and Southern Pacific 33.

TABLE 7-25

COMPLIANCE IMPACTS FOR THE STUDY LEVELS, L_{dn} 70; ε_d - -1.41

Railroad	Percentage Increase In Price	Percentage Decrease In Demand	Decrease In Employment or No. Workers Idled
(A - Based on Heaviest Employment Impacts)			
Conrail	0.1	0.1	119
Burlington Northern	0.1	0.1	39
Southern Pacific	0.1	0.2	21
Atchison, Topeka & Santa Fe	0.1	0.1	21
(B - Based on Largest Price Increases)			
Detroit & Toledo Shoreline	0.8	1.1	2
Texas Mexican	0.6	0.9	2
Richmond, Fredericksburg, & Potomac	0.6	0.9	5
Detroit, Toledo & Ironton	0.5	0.6	0
Central Vermont	0.4	0.6	2

Study Level L_{dn} 65 with the price elasticity of demand assumed to be -0.39

Results of the impacts on price, demand/output, and employment for the most heavily impacted railroads are presented in Table 7-26.

Note that these impacts are heavier than at the study level L_{dn} 70, as expected. In general, consistency is indicated insofar as the same group of railways, more or less, reappear in each analysis, as may be expected. Moreover, these analyses quantify the results of the expected financial impacts.

For railroads with $\varepsilon_d = -0.39$, the median price increase would be about 2.0 percent and demand would fall by about 0.8 percent. Unemployment or underemployment would increase by about 52 workers per firm, and about 2547 overall. The largest expected price increase is about 4.9 percent. The largest employment cutbacks would occur for the railroads employing the most workers in general.

TABLE 7-26

COMPLIANCE IMPACTS FOR THE STUDY LEVELS, L_{dn} 65; ε_d - -0.39

(A - Based on Heaviest Employment Impacts)

Railroad	Percentage Increase In Price	Percentage Decrease In Demand	Decrease In Employment or No. Workers Idled
Conrail	2.1	0.8	714
Burlington Northern	1.5	0.6	216
Southern Pacific	0.8	0.3	116
Illinois Central Gulf	2.0	0.8	115
Atchison, Topeka & Santa Fe	1.1	0.4	115
(B - Based on Largest Price Increases)			
Texas Mexican	4.9	1.9	5
Central Vermont	4.8	1.9	7
Illinois Terminal	3.9	1.5	7
Bangor & Aroostook	3.3	1.3	9
Delaware & Hudson	3.0	1.2	21

Study Level L_{dn} 65 with the price elasticity of demand assumed to be -1.41

The most stringent study level analyzed is presented in Table 7-27. Accordingly, the largest price increase required is sizeable (i.e., 6.8 percent). The median price increase is 2.6 percent.

The number of workers underemployed or laid off is approximately 250 per firm, for a total of 12,200 which is about 2.5 percent of the Class I railroad work force in 1976.

TABLE 7-27

COMPLIANCE IMPACTS FOR THE STUDY LEVELS, L_{dn} 65; ε_d - -1.41

(A - Based on Heaviest Employment Impacts)

Railroad	Percentage Increase In Price	Percentage Decrease In Demand	Decrease In Employment or No. Workers Idled
Conrail	2.6	3.6	23
Burlington Northern	2.0	2.8	1015
Norfolk & Western	2.8	3.9	654
Baltimore & Ohio	3.6	5.0	602
Chicago & Northwestern	3.8	5.4	570
(B - Based on Largest Price Increases)			
Texas Mexican	6.8	9.6	23
Illinois Terminal	5.5	7.8	35
Central Vermont	5,4	7.7	30
Richmond, Fredericksburg and Potomac	5.4	7.6	47
Soo Line	4.2	5.9	1.83

Aggregate Decline in Demand for Rail Services, Employment, or Productivity Associated with Price Increases

Study Level L_{dn} 70; $\varepsilon_d = -0.39$:

For the least stringent study noise level analyzed (L_{dn} 70) and an average price elasticity of demand of -0.39, the demand impacts on 49 individual railroads were estimated and aggregated. Based on 1976 total revenue and non-revenue ton-miles, the price increases necessary for compliance with this level would result in a decline in annual demand of about 0.1 percent of the 1976 total. This decline would idle about 120 railroad employees based on the 1976 level of employment and the statistical relationship between employment and railroad activity. If workers were not laid off, labor productivity would decline by 0.1 percent.

Study Level L_{dn} 70; $\varepsilon_d = -1,41$:

For the study noise level (L_{dn} 70) and price elasticity of demand of -1.41, the demand for railroad services could be expected to decline by about 0.3 percent of the 1976 total, if compliance costs were to be passed forward as price increases by 49 of the major railroads.

As a result of this cutback in demand, about 540 employees would be idled or laid off among 49 railroads, if labor productivity losses were to be avoided. This labor productivity loss would be 0.3 percent.

Study Level L_{dn} 65; $\varepsilon_d = -0.39$:

To achieve this study level of noise abatement, demand for railroad services based on the original level of ton-miles in 1976 would decline by 0.9 percent of 1976 demand. As a result, employment would have to be cut by about 2550 employees, if productivity losses were to be avoided. If not, the labor productivity decline would be 0.9 percent.

Study Level L_{dn} 65; $\varepsilon_d = -1.41$:

This study level is the most stringent one analyzed here. Using 1976 data again as a base, demand would drop about 4.6 percent. The decrease in employment would be about 12,200 or an equivalent decline in productivity because of underemployment. This decline in labor productivity would be about 4.6 percent.

Bankrupt Roads

The roads listed below represent carriers which fall within the categories of near bankruptcy, declared bankruptcy or reorganized:

1. Grand Trunk Western Railroad (GTW)
2. Canadian Pacific Lines in Maine (CP)
3. Long Island Railroad (LI)
4. Missouri-Kansas-Texas Railroad (MKT)
5. Conrail, (CON)
6. Boston and Maine Railroad (BM)
7. Chicago, Milwaukee, St. Paul and Pacific Railroad (MILW)
8. Chicago, Rock Island and Pacific Railroad (RI)
9. Morristown & Erie Railroad, (ME)

The first two carriers (Grand Trunk Western and Canadian Pacific Lines in Maine) are wholly owned subsidiaries of Canadian roads, and the third (Long Island Railroad) is controlled by the State of New York. Because of their external cash flow, these three carriers have been excluded from further analysis. The last four carriers listed above (Boston & Maine; Chicago, Milwaukee, St. Paul & Pacific; Chicago, Rock Island & Pacific; and Morristown & Erie) have already been declared bankrupt.

For each road indicated above[d], estimates were made of: a) the percentage price increase, b) the percentage decrease demand for rail freight services, and c) the decrease in employment or in the number of workers idled. These impact indicators were computed on the basis of the proposed noise study levels, applying an assumption that all yards per firm were to be quieted to a noise level of either L_{dn} 70 or L_{dn} 65. Aggregate average price elasticities of demand (ε_d), representing a weighted low and a weighted high estimate, were used as a base for the indicators shown in Table 7-28.

Other roads which are financially weak have been discussed in the preceding section. A full listing of the financial ratios of all firms is given in Appendix G.

Conclusions

As discussed earlier in this section, the costs and economic impacts are not derived directly from the revised health/welfare noise model, but instead utilized an earlier version of this model because of time limitations. The costs and economic impacts may be more severe than those reported on in this section by some unknown amount. Further study and analysis seems to be warranted to make such a determination, as well as to make the necessary adjustments, as applicable, related to compliance costs and economic impacts.

On the basis of the estimated costs to meet the various noise regulatory levels and the analysis of the economic impacts corresponding to these levels, a number of conclusions can be drawn. These are presented below.

1. The estimated costs of compliance were developed for 5 distinct levels and it was observed that the cots markedly increase at the L_{dn} 65 level. Based upon these results, the economic impact analysis focused on both the L_{dn} 70 and L_{dn} 65 noise regulatory study levels. The major feature of the increase at the lower level was caused by the need to curtail nighttime operations so that noise emissions could be reduced to meet the required level. Employment of available noise abatement procedures are not capable of reducing noise emissions to the desired level within flat classification yards unless nighttime activity curtailment of operations is implemented.

TABLE 7-28

ECONOMIC IMPACTS ON ROADS FALLING IN CATEGORIES OF:
(a) Near Bankruptcy, (b) Declared Bankruptcy, or (c) Reorganized

STUDY LEVEL, L_{dn} 70 dBA

	$\varepsilon_d = -0.39$			$\varepsilon_d = -1.41$		
RAIL ROAD	PER-CENTAGE PRICE INCREASE	PER-CENTAGE PRICE DECREASE	EMPLOY-MENT DECREASE OR NO. OF WORKERS IDLED	PER-CENTAGE PRICE INCREASE	PER-CENTAGE DEMAND DECREASE	EMPLOY-MENT DECREASE OR NO. OF WORKERS IDLED
GTW	0.1	0.0*	1	0.1	0.2	6
CP	0.0*	0.0*	0	0.0*	0.0*	0
LI	0.1	0.0*	3	0.0*	0.1	8
MKT	0.2	0.1	1	0.2	0.3	5
CON**	0.1	0.0*	29	0.1	0.1	119
BM	0.2	0.1	2	0.2	0.3	8
MILW	0.1	0.0*	4	0.1	0.1	15
RI	0.1	0.0*	3	0.1	0.2	12
STUDY LEVEL, L_{dn} 65 dBA.						
GTW	1.9	0.7	24	2.6	3.6	117
CP	0.0*	0.0*	0	0.0*	0.0*	0
LI	0.3	0.1	15	0.2	0.3	34
MKT	2.7	1.1	20	3.8	5.3	99
CON**	2.1	0.8	714	2.6	3.6	3056
BM	2.5	1.0	25	3.0	4.3	112
MILW	2.4	0.9	112	2.4	3.4	407
RI	2.2	0.9	60	2.9	4.1	285

* 0.0 indicates less than 0.05.

** Estimates for Conrail were made from data available on four of the largest firms reorganized into Conrail: Erie Lackawanna, Lehigh Valley, Reading, and Penn Central. The contributions from the other component firms are expected to be small, and will only increase the unemployment estimates slightly.

Legend for Listed Railroads:

1. (GTW) Grand Trunk Western Railroad
2. (CP) Canadian Pacific Lines in Maine
3. (LI) Long Island Railroad
4. (MKT) Missouri-Kansas-Texas Railroad
5. (CON) Conrail
6. (BM) Boston and Maine Railroad
7. (MILW) Chicago, Milwaukee, St. Paul and Pacific Railroad
8. (RI) Chicago, Rock Island and Pacific Railroad

2. The estimated costs related to nighttime curtailment pertain to operations only and require such operations (car classifications) to be switched over to daytime operations. It was not feasible to estimate costs of such curtailment in operations on segments or the entire railroad system, since the focus of this study was on rail yard noise. Railroad systems cost implications, as they might relate to freight services and effects on the marketplace resulting from nighttime curtailment of yard operations were not attempted. It is expected that such costs would be extremely high.

3. Economic impacts on the railroad industry and on individual carriers can range widely depending upon the price elasticity of demand. The elasticities have been shown to range from -0.39 to -1.41. This range, together with different costs estimated to reduce noise emissions to meet the various regulatory study levels, can make significant differences by an order of magnitude in the derived statements of impact. On the other hand, this method of bounding the problem provides the insight needed to determine the magnitude of the effects caused by adopting a particular noise regulatory study level on the industry, as well as on individual rail carriers. This procedure appears realistic in light of the state of knowledge about the paucity of data on price elasticity of demand on a firm-by-firm basis.

4. The costs of noise control through the use of noise source abatement procedures are not high when compared to the industry's economic and financial statistics. The financial condition of the industry and that of individual carriers are not altered significantly by the added expenses required to achieve the regulatory study levels that were analyzed in detail. It is recognized that this analysis used but one year's data and abnormalities occurring in the year studied could alter the results to some degree. However, it is concluded that the outcome should not be significant to alter the analysis conducted.

5. Extending the property of railroad yards to establish the yard perimeter sufficiently far from yard noise sources to meet the regulatory study levels is relatively expensive as compared to implementation of noise abatement procedures. Property acquisition seems to be the only alternative when other techniques are not sufficient to meet a given noise standard.

6. Supply problems involving either energy sources or material required for noise abatement equipment and facilities should be insignificant. Small amounts of additional diesel fuel would be consumed with improved switch engine mufflers. The supplies required to fabricate and produce the quantities needed to implement the other noise abatement procedures represent small portions of the products currently being manufactured.

7. The impact of the noise regulatory study levels analyzed on prices, demand for services, and employment does not appear significant when viewed in terms of the entire railroad industry. However, on the basis of individual railroad carriers, the impacts observed do not vary widely over the firms studied. The majority (90 percent) of Class I line-haul railroads have a need to increase prices to no more than 5 percent above the 1976 unit price as a result of an analysis at the most stringent level analyzed. Similarly, this seems to hold also for employment.

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FOOTNOTES

a. The employment effects analyzed are only those resulting from a decrease in 'adjusted' revenues. (See discussion in Appendix H.) The potential increase in employment for installation, operation and maintenance of noise abatement procedures is not considered in this table of results.

b. Rail Merger Study, Rail Services Planning Office, Washington, D.C., April 1977.

c. Moody's Transportation Manual, 1977; Moody's Investors Service, Inc., New York, 1977.

d. Estimates for Morristown & Erie were not made due to lack of data.

REFERENCES

1. Economic News Notes, National Association of Home Builders, Washington, D.C., May 1978.

2. Historical Analysis of Unit Land, Prices, Real Estate Research Corporation, Chicago, Illinois, 1973 (unpublished report to HUD).

3. Farm Real Estate Market Develoment, Economics, Statistics and Cooperative Service, U.S. Department of Agriculture, July 1978.

4. Current Industrial Reports: Fibrous Glass, p. 3, Table 2, Bureau of the Census, May 1978.

5. Predicasts Base Book, Predicasts, Inc., 1977.

6. Ibid., p. 18.

7. Altman, E. I., "Railroad Bankruptcy Property", Journal of Finance, Papers and Proceedings, December 1970.

8. The Impact of the 4-R Act Railroad Rate - Making Provision, Interstate Commerce Commission, Washington, D. C., October 1977.

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF NOISE ABATEMENT AND CONTROL

APPENDICES TO BACKGROUND DOCUMENT FOR REVISED RAILROAD NOISE EMISSION STANDARDS

FEBRUARY 1979

9-66

APPENDIX A

NOISE MEASUREMENT METHODOLOGY

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NOISE MEASUREMENT METHODOLOGY

Part A: Noise Measurement Methodology for Community Locations

Determination of compliance with the noise standards for railroad facilities at a community measurement location involves answering the following two questions:

1. Does the railroad component of the day-night sound level exceed the limit value?
2. Is the railroad noise the dominant source of noise at the measurement location?

Answering these questions involves measurement of the total day-night sound level, and measurement or estimation of the railroad and non-railroad components of the day-night sound level.

Railroad operations can be classified into infrequent and continuous operations. Infrequent operations are those which occur during a period that has a total duration of less than two weeks during an entire year. Continuous operations are those that regularly occur in the normal year and are not classified as infrequent; continuous operations can further be divided into two categories depending upon the variability of the operations. In order to define "normal" operations, the concept of an annual average day is used. The number of operations on an annual average day is the number of annual operations during the most recent year in which information is available, divided by 365. The "week operations ratio" is the number of operations of a specific kind for a specific week divided by 7 times the number of operations on an annual average day. Continuous operations are considered to be normal when the week operations ratio throughout 50 weeks of the year does not exceed the range of 1/3 to 3. Continuous operations are considered to be irregular when there is a high week operations ratio (less than 1/3). This classification of railroad operations into infrequent and continuous operations, with subdivision into normal and irregular operations, is illustrated in Figure 1.

The noise of non-railroad sources in the community can be considered a mixture of a variety of sources, such as traffic, aircraft, industry, etc. For locations in residential areas where no specific noise sources are identifiable, the day-night sound level of urban residential noise may be approximated by the expression $10_{\log} p + 22$, where p is the number of people per square mile living in the area. In areas with additional sources, the noise of these sources can be super-imposed on the residential approximation to provide a measure of the total noise exposure.

The noise of railroad operations is considered to be dominant over the noise of other sources in the community if either of the following two situations occur:

a. The noise of railroad operations is clearly dominant over the noise of non-railroad sources. This may be demonstrated if the railroad component of the day-night sound leve is 6 dB or more above the non-railroad component of the day-night sound level (or, equivalently, if the total day-night sound level is 7 dB or more obove the non-railroad component). In urban residential areas with no specific identifiable noise sources, the approximation above ($10_{\log} p + 22$) may be used as an estimate of the non-railroad noise exposure in this demonstration of clear dominance.

b. The noise of railroad operations is considered dominant over the noise of non-railroad sources if the railroad component of the day-night sound level exceeds the non-railroad component of the day-night sound level by 3 dB or more. To demonstrate this dominance condition, both components (rail and non-rail) must be measured and/or estimated based on measurements at the measurement location. Further, the sum of the rail and non-rail components must be within 2 dB of the measured total day-night sound level at the measurement location.

When the railroad noise is high and the non-railroad noise is low at a particular measurement location, the measurement methodology provides a simple process for determining compliance. When this situation does not occur, the procedure for determining compliance is more complicated. It is therefore desirable for enforcement purposes to select a community measurement location where the first set of conditions apply. Described below are the general procedures which culd be followed for both the simple and complicated cases of compliance determination.

Measurement Instrumentation

(a) An integrating sound level meter, or instrumentation system, that meets all of the requirements of American National Standard for Sound Level Meters S1.4-1971, Type 1 shall be used. The integrating sound level meter shall be capable of meeting the Type 1 tolerances for the sound level meter when used with an ideal integrator for the following functions (where applicable) and signals:

1. Sound Exposure Level: For sinusoidal signals in its stated operating range with duration varying between 1 second and 3600 seconds, with the maximum sound exposure level of at least 135 dB re (20

micro pascals) squared and one second. An additional tolerance of ± 1 dB is allowed for events which have a duration of between 100 milliseconds and 1 second.

2. Equivalent Sound Level: For sinusoidal signals with sound levels varying between 45 and 125 dB, and frequencies between 200 and 1000 Hertz, and for any combination of sound levels whose durations range between 1 second and 3600 seconds for hourly equivalent sound level, except that the maximum hourly equivalent sound level need not exceed 100 dB.

3. Day-Night Sound Level: For signals specified in (2) above during daytime hours and for signals that are ten decibels lower during nighttime hours (0000 to 0700) and (2200 to 2400).

(b) A microphone windscreen and an acoustic calibrator of the coupler type shall be used as recommended by: (1) the manufacturer of the sound level meter or (2) the manufacturer of the microphone.

Measurement Location and Weather Criteria

(a) Enforcement measurements shall be conducted only at receiving property locations where the sound from railroad facility operations is dominant.

(b) No measurement shall be made within 10 meters distance from any substantially vertical reflecting surface that exceeds 1.2 meters in height, except for measurements on a residentials dwelling measurement surface.

(c) No measurement shall be made when the average wind velocity during the period of measurement exceeds 12 mph (19.3 kph) or when the maximum wind gust velocity exceeds 20 mph (32.2 kph).

(d) No measurements shall be taken when precipitation (rain, snow, sleet, etc.) occurs for a period exceeding 20% of the measurement period, unless it can be demonstrated that the precipitation does not increase the sound level at the microphone.

Procedures for Measurement

(a) General Approach

The procedures for determination of the component sound level resulting from railroad facility operations and demonstration that it is the dominant sound component for the purpose of Part B of this part are as follows:

(1) Select a location for measurement;

(2) Determine the level, either hourly equivalent sound level, or day-night sound level, by measurement;

(3) Determine the railroad facility component sound level and demonstrate dominance by using either the procedures for clear dominance when it exists, or the procedure for dominance where

(b) Microphone Location

The microphone shall be positioned at a height between 1.2 and 1.5 meters above the ground, except, that on a residential dwelling measurement surface as exemplified in Figure A-1 the microphone may be positioned at any height that is greater than 1.2 meters above the ground and less than the height of the uppermost interior ceiling immediately adjacent to the location on the measurement surface, or 7 meters, whichever is less. The location shall be selected where it is expected that dominance can be demonstrated, and the conditions of measurement shall be selected such that the criteria of Sec. 201.32 are satisfied.

(c) Determine the Measured Level

The hourly equivalent sound level in any daytime or nighttime hour, or the day-night sound level in any continuous 24-hour period, as desired, shall be measured.

(d) Rail Facility Component Hourly Equivalent Sound Level or Day-Night Sound Level When it is the Clearly Dominant Sound

Clear dominance exists when the measured hourly equivalent or day-night sound level exceeds the component hourly equivalent or day-night sound level from non-railroad facility and through train operations by 7 dB or more. When clear dominance is shown to exist, the rail facility component hourly equivalent sound level or day-night sound level for the purpose of Subpart B shall be determined by subtracting one decibel from the measured level. For this purpose the following procedures, or functional equivalents thereof, shall be used to estimate the non-railroad facility component hourly equivalent or day-night sound level:

(1) The component hourly equivalent sound level or day-night sound level resulting from non-railroad and through train operations shall be calculated by summing on an energy basis the component sound levels from each of the significant source components present. If the measurement is in a residential neighborhood where no other significant source is present, including through trains, the non-railroad component sound level is deemed to be the non-railroad and through train component sound level. For this purpose a source is considered significant if its component sound level is within 12 dB of the measured sound level. Methods for determining the component sound levels for several types of sources are given in the following:

(A) For a measurement location in a residential neighborhood, in which the sound from non-neighborhood sources, such as major streets or highways, industrial, commercial, or public establishment, aircraft, construction, etc., is not identifiable, the residential neighborhood componente day-night sound level shall be estimated to be equal to or less than the quantity [22 + 10 log (population density)]. The population density shall be determined by dividing the population of the census tract which contains the measurement location, by the area in square miles of the residential portion of the census tract. The residential neighborhood component hourly equivalent sound level for day time hours shall be estimated by adding 1 dB to the estimated day-night sound level, and for nighttime hours by substracting 6 dB from the estimated day-night sound level.

(B) For a measurement location where a significant source of noise is civil aircraft, the aircraft component hourly equivalent sound level or day-night sound level shall be estimated using the procedures contained in the EPA document, "Calculation of Day-Night Levels Resulting From Civil Aircraft Operations," EPA 550/9-77-450 (January 1977). In using these procedures, the number of aircraft operations on flight tracks which affect the noise at the community location shall be that occurring during the period of measurements.

(C) For a measurement location where a significant source of noise is the motor vehicle traffic on a nearby roadway, the traffic component hourly equivalent sound level or day-night sound level shall be estimated using the procedures contained in the Federal Highway Administration document, "User Manual: TSC Highway Noise Prediction Code: Mod 04," FHWA-RD-77-18 (January 1977). In using these procedures, the traffic flow characteristics during each hour of the measurement day shall be used to estimate the hourly equivalent sound levels throughout the day; these shall be weighted for time of day and summed on an energy basis to obtain the traffic component day-night sound level.

Alternatively, if through trains operate on a regular basis, the through train component hourly equivalent and day-night sound level for these trains may be computed, assuming the scheduled times for purposes of nighttime weighting (unless the actual times are known), from the average sound exposure level measured for through trains at the location. The average sound exposure level shall be determined from an energy average of the measured sound exposure levels. For computation, the total number of measurements shall be at least five through trains.

(D) For a measurement location where a significant source of noise is through trains which move continuously through a railroad facility during the measurement period the through train component hourly equivalent sound level or day-night sound level shall be measured during the period.

(E) For a measurement location where a significant source of noise is other than the above, the component hourly equivalent sound level or day-night sound level for each significant source shall be determined from measurements.

(2) For any measurement at a receiving property location the demonstration of clear dominance for the measured hourly equivalent sound level may be based on a comparison of the

value of the measured hourly equivalent sound level obtained in an hour in which operations in the railroad facility were judged to dominate the sound with the value of an hourly equivalent sound level obtained in prior or subsequent period, or a combination of both, in which the sound from operations in the railroad facility were judged to be less dominant, with both of these values measured within a total elapsed time not exceeding four hours. When the difference between the former and latter values of measured hourly equivalent sound level equals or exceeds 7 dB, clear dominance is demonstrated.

(e) Rail Facility Component Hourly Equivalent or Day-Night Sound Level and Dominance when Clear Dominance cannot be Demonstrated

Dominance exists when the measured hourly equivalent or day-night sound level exceeds the rail facility component level by 3 dB or less. Dominance of the rail facility component day-night sound level shall be demonstrated for the purpose of subpart B of these regulations by showing that the calculated rail facility component sound level exceeds the non-railroad facility component sound level by at least three decibels, and that the level calculated on an energy basis from these two quantities is within 2 dB of the measured sound level less the through trains component sound level. For this purpose the non-railroad facility component sound level and the through train component sound level may be determined by the procedures in Sec. 201.33d, and the rail facility component level determined by the following, or functional equivalent thereof:

(1) Calculate the partial rail facility component day-night sound level from the values of rail facility component equivalent sound level measured under conditions of clear dominance, Sec. 201.33d above.

(2) Determine the energy average sound exposure level for each noise source which contributes significantly to the noise at the measurement location. For this determination, the average value for each type of source should be based on at least five measurements or a number equal to the range of measured levels in decibels. Compute the rail facility component sound level from the energy average sound exposure levels for each significant source, type, the number of such source types operating per hour or day (by time of day), and their distance between source and receiver.

Part B: Noise Measurement Methodology for Retarder Car Coupling and Mechanical Refrigerator Cars

Measurement Instrumentation

(a) A sound level meter or alternate sound level measurement system that meets, as a minimum, all the requirements of American National Standard S1.4--1971* for a Type 1 instrument shall be used with the "fast" meter response characteristic. To insure Type 1 response, the manufacturer's instructions regarding mounting of the microphone and positioning of the observer shall be observed.

(b) In conducting the sound level measurements, the general requirements and procedures of American National Standard S1.3--1971* shall be followed, except as specified otherwise herein.

(c) A microphone windscreen and an acoustic calibrator of the coupler type shall be used as recommended by: (1) the manufacturer of the sound level meter or (2) the manufacturer of the microphone.

(a) Measurement locations shall be selected such that the maximum sound level from railroad equipment is not increased by more than 1.0 dB by sounds reflected from any surface located behind the microphone.

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* American National Standards are available from the American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018

The phrase "located behind the microphone" means located beyond a line (or family of lines) drawn through the microphone and perpendicular to the line(s) between any point on the rail equipment and the microphone. (Area A in Figure A-2). This acoustical condition shall be considered fulfilled if the following conditions exist:

1. No substantially vertical surfaces of greater than 1.2 meters height (i.e. walls, cliffs, etc.) are located within an arc of 30 meters radius behind the microphone (Area B in Figure A-2).
2. No substantially vertical surfaces, placed so they reflect significant railroad sound to the microphone, which subtend an angle of greater than 20 degrees when measured from the microphone in either the vertical and most nearly horizontal planes, are located within an arc of 100 meters behind the microphone (Area C in Figure A-2).

(b) Miscellaneous objects may be located between the railroad equipment and microphone, except that all objects which break the line-of-sight of the equipment must be closer to the equipment than to the microphone; that is, along a line between the microphone and any point on the equipment, at the point of intersection with the object the distance to the equipment must be shorter than the distance to the microphone.

(c) Other railroad equipment may be located behind the equipment whose noise is being measured (Area D in Figure A-2).

(d) The ground elevation at the microphone location shall be within plus 5 ft. or minus 10 ft. of the ground elevation of the source whose sound level is being measured.

(e) Measurements shall not be made during precipitation.

(f) Noise measurements may only be made if the average measured wind velocity is 12 mph (19.3 kph) or less, and the maximum wind gust velocity is less than 20 mph (33.2 kph).

Procedures for the Measurement of Retarder, Car Coupling, and Mechanical Refrigeration Car Noise

(a) Refrigeration Car Test. The microphone shall be positioned at any location 7 meters from the centerline of the refrigeration car track, and between 1.2 meters above the ground and the height corresponding to the top of the refrigeration car. The microphone shall be oriented with respect to the equipment in accordance with the manufacturer's recommendations. No observer shall stand between the microphone and the equipment being measured. The observer shall position the microphone in accordance with the manufacturer's instructions for Type 1 performance. The standard shall not be exceeded during any thirty second period after the throttle setting is established.

(b) Car Coupling Test. The microphone shall be positioned at a location 30 meters from the centerline of the coupling track, and at a height between 1.2 and 1.5 meters above the ground. The microphone shall be oriented with respect to the equipment in accordance with the manufacturer's recommendations. No observer shall stand between the microphone and the equipment being measured. The observer shall position the microphone in accordance with the manufacturer's instructions for Type 1 performance. The maximum sound level, L_{max} of individual car impacts shall be measured, and the average value (energy average) of these maximum levels, L_{max}, shall not exceed the standard.

The total number of measurements shall be at least ten.

(c) Retarder Test. The microphone shall be positioned at a location 30 meters from the centerline of the retarder track, and at a height between 1.2 and 1.5 meters above the ground. The microphone shall be oriented with respect to the equipment in accordance with the manufacturer's recommendations. No observer shall stand between the microphone and the equipment being measured. The observer shall position the microphone in accordance with the manufacturer's instructions for Type 1 performance. The maximum sound level, L_{max}, of individual retarder squeals shall be measured, and the average value (energy average) of these maximum levels L_{max} shall not exceed the standard.

The total number of measurements shall be at least ten.

(d) Alternative Microphone Locations. (1) If the criteria of Sec. 201.26 do not permit measurements at the distances defined above, the measurement location may be adjusted within the distance limits listed in Table 1 below. When such an alternate location is selected, the measured maximum sound level shall be adjusted by addition of the amount listed in Table 1 for the appropriate distance.

(2) The microphone shall be oriented with respect to the equipment in accordance with the manufacturer's recommendations. No observer shall stand between the microphone and the equipment being measured. The observer shall position the microphone in accordance with the manufacturer's instructions for Type 1 performance.

Table 1

Adjustment to L_{max} for Variable Measurement Distances

Measurement Distance from Equipment, Meters		Adjustment to
Retarders and Car Couplings	Refrigerator Cars	Lmax dB
16.0 - 17.8		-5
17.9 - 20.0		-4
20.1 - 22.5		-3
22.6 - 25.2		-2
25.3 - 28.3		-1
28.4 - 31.7	6.7 - 7.3	0
31.8 - 35.6	7.4 - 8.2	1
35.7 - 39.9	8.3 - 9.2	2
40.0 - 44-8	9.3 - 10.4	3
44.9 - 50.3	10.5 - 11.7	4
50.4 - 56.4	11.8 - 13.1	5
--	13.2 - 14.7	6
--	14.8 - 16.5	7
--	16.6 - 18.5	8
--	18.6 - 20.8	9
	20.9 - 23.2	10

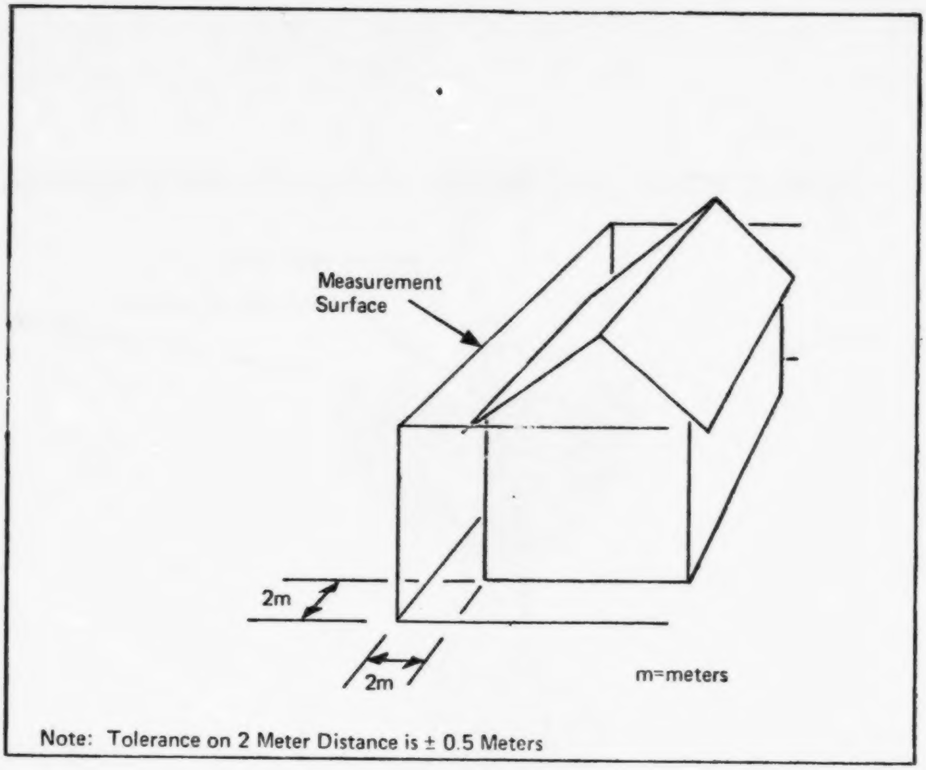

Figure A-1: Residential Receiving Property Measurement Surface

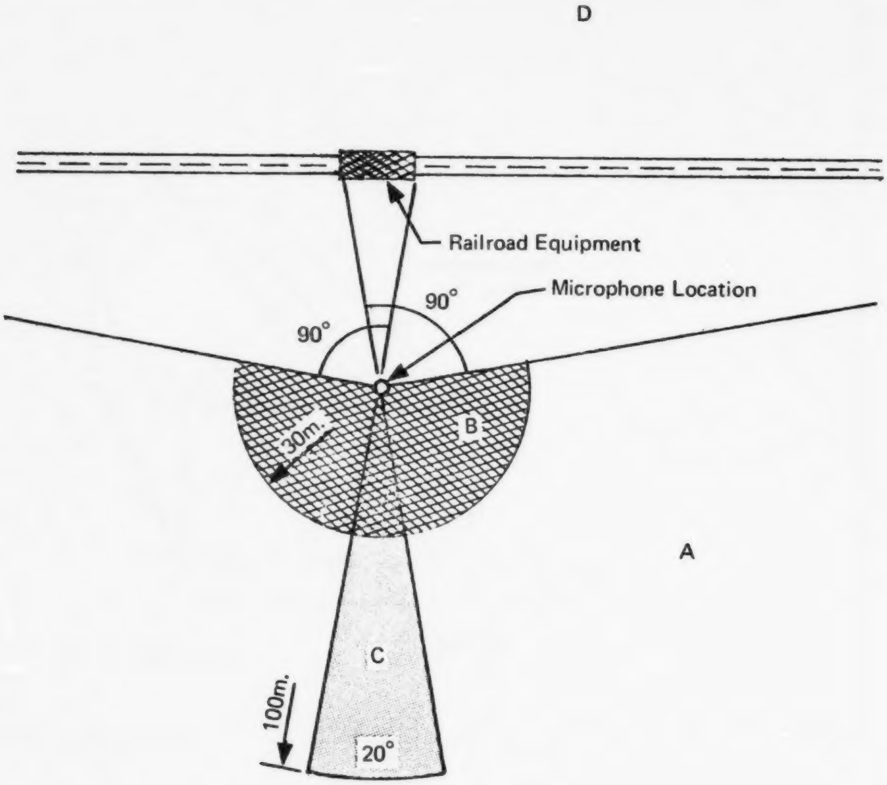

Figure A-2: Retarder, Car Coupling and Mechanical Refigerator
Car Areas of Consideration for Noise Testing

APPENDIX B

RAIL YARD NOISE MEASUREMENT DATA

Appendix B

Over 400 pages of rail yard noise data comprise Appendix B. The data are derived from three sources:

(1)	Measurements performed for EPA by contractors	Pg B-1
(2)	Measurements performed by EPA regional representatives (reference B-1)	Pg B-243
(3)	Measurements performed for the AAR and provided to the EPA	Pg B-319

Because of its volume, Appendix B has been printed separately and is available from:

Mr. Charles Mooney
EPA Public Information Center
(PM-215) Room 2194D
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

APPENDIX C

NOISE SOURCE ABATEMENT COST ESTIMATES

Presented in this appendix are descriptions of the methods and data sources used in deriving cost estimates for each of the noise source abatement procedures contained in this study.

In developing these cost estimates no costs are included for disruption of service or removal of equipment and facilities from service. The basis for this assumption is that sufficient time will be available for compliance with the noise regulation.

Depending on the noise standard and the type of railroad equipment being treated, the compliance period under consideration would extend over a four to six year time period. This period would permit the installation of noise abatement equipment without incurring a cost for interrupting operations, and in some cases, without incurring costs specifically related to the installation of noise abatement equipment.

For example, given sufficient time, the modification indicated for quieting switch engines and refrigerator cars can be accomplished as a part of normal maintenance operations. Railroad cars and locomotives normally receive routine maintenance and overhaul on a regular basis. A four to six year compliance period would permit the modifications to be made during such normal maintenance operations.

The compliance period also has implications for constructing noise barriers and installing track equipment. With sufficient time, the construction and installation in most instances can be made without disrupting yard operations. Slack periods can be used to divert operations away from a portion of the retarders for barrier construction purposes, or for making modifications.

An added consideration is that lengthy procurement lead times for the noise abatement equipment considered should not be necessary. One of the criteria for selecting the noise abatement techniques was that the technique be available and that research and product development would not be necessary. An increase in demand because of the requirements for noise regulation may deplete manufacturers' or distributors' stocks, but from the standpoint of technological development, the equipment would be available. Thus, all required noise abatement techniques should be easily installed within a reasonable compliance period.

Retarder Barriers

The type of noise barriers used as the basis for the cost estimates involve acoustical panels placed along both sides of the retarders. The materials would typically consist of a heavy backing panel, faced with acoustical material, and then surfaced with a perforated or expanded metal covering. The barrier would range from 8 to 12 feet high and cost $75 per linear foot installed.[1] The useful life of retarder barriers is estimated to be 10 years.

1. Master Retarders

For master retarders, which average 150 feet in length, an average total of 300 feet of barrier would be required for both sides of the retarder. The estimated cost, therefore, would be 300 feet times $75 per linear foot installed, or $22,500 per railroad yard barrier set.

2. Group Retarders

Group retarders average 100 feet in length. The same barriers as those considered above for master retarders would be used. There is an average of six group retarders per railroad yard. To erect a barrier on both sides, 200 feet would be required, resulting in a total requirement of 1200 feet for the six group retarders. The cost, therefore, would be 1200 feet times $75 or $90,000 per railroad yard, or $15,000 per group retarder.

Lubrication System

A lubrication system for a single retarder in a hump classification yard is estimated to cost approximately $250,000. The consumption of oil in this system is assumed to be about 75 gallons per day. These data were developed from a description of the system and its components, based upon discussions with industry representatives, and the article entitled "The Quiet One, Burlington Northern's Northtown Yard," Walker, M.B., V77, Proceeding #658, AREA 76, pps. 555-561. The useful life of a retarder lubrication system is assumed to be 10 years.

Ductile Iron Shoes

A noise abatement technique under consideration for reducing retarder noise involves substituting ductile iron shoes on one side of the retarder for which steel retarder shoes which are normally used. Ductile iron shoes would be used in hump yards for both master retarders and group retarders. The cost attributable to noise abatement is the incremental cost, i.e., the difference between the usual practice of using only steel shoes and the cost of using ductile iron shoes on one side of the retarder.

One side of a master retarder requires 50 ductile iron shoes at a cost of approximately $115 per shoe. Since installation of such shoes requires about 15 minutes and can be accomplished as part of routine retarder shoe replacement, incremental costs for installation are regarded as being insignificant.

An important cost consideration that is accounted for in the cost estimate is that ductile iron shoes wear out faster than steel shoes in a one side application.

The annual cost incurred for steel shoes in $14,000. The annual cost incurred when ductile iron shoes are placed on one side, considering they wear out 5 to 7 times faster than steel shoes is approximately $81,000.

The incremental cost, therefore, attributable to this noise abatement technique is the difference, or $67,000 per master retarder.

In addition to master retarders, there are also group retarders that would be modified with ductile iron shoes on one side. There are six group retarders in a typical hump classification yard. Group retarders are approximately 100 feet in length, or two-thirds the length of master retarders, therefore the cost per group retarder is one-third less than the master retarder cost.

An important consideration is that since there are typically six classification groups per hump yard, the group retarders on the average handle only one-sixth as much traffic as the master retarders. The longer shoe life would result in the replacement rate being one-sixth of that of master retarders.

These considerations for group retarders can be organized into the following estimating equation:

$Cg = Cm \times L \times U \times N$

Cg = Cost of replacing group retarder shoes with ductile iron shoes on one side

Cm = Cost of replacing master retarder shoes with ductile iron shoes on one side

L = Adjustment for difference in length

U = Adjustment for longer life

N = Number of group retarders for typical hump yard

$Cg = 67{,}000 \times .67 \times .17 \times 6$

$Cg = 45{,}000$

Total annual incremental cost per hump classification is $67,000 for master retarder modification plus $45,000 for group retarders. Therefore, the total annual incremental cost is $112,000 per yard.

Releasable Retarders

Inert retarders can be replaced by releasable retarders for the purpose of noise control of that source. EPA Background Document (R13-14)[3] estimates a $7,500 cost for each releasable retarder. With an addition for inflation and installation, an estimate of $10,000 per releasable retarder is used here.

All hump yards that are not automated are considered to require releasable retarders. It was estimated that about 20 percent of automated yards already have releasable retarders.[4] The average hump yard has 37 tracks.[3] Therefore, 37 tracks times 108 yards requiring releasable retarders equals a quantity of 3996 releasable retarders in hump yards. The useful life of releasable retarders is estimated at 10 years.

Refrigerator Cars

Of the 98,000 refrigerator cars operating on the nation's rail system, 24,000 are mechanically refrigerated and require quieting. Mechanical equipment for car refrigeration includes a power plant (usually a diesel-electric unit), a refrigerant compressor, a refrigerant condenser and fan, an evaporator and a fan or fans for the distribution of the cooled air through or around the lading. Defrosting is usually done automatically by electric coils mounted in the evaporator, which are utilized for car heating also, when heat is called for by the thermostat. This equipment is mounted in one end of the car.

Noise abatement techniques for refrigerator cars and their costs are presented in the following:

Techniques and Costs[8]

Improved muffler	$ 10	additional cost
Insulation	90	
Fan modification	10	
Total incremental cost	$110	

Applying these unit costs to the 24,000 cars results in a capital cost for quieting refrigerator cars of $2,640,000.

Considering a five year life for mufflers and 25 years for insulation and fan modifications, the added cost for replacement would average $14 per year per car. The total incremental replacement cost, therefore, would be $32,800 annually.

Switch Engines

Quieting switch engines consists of installing mufflers. Data from ICC sources indicates a national inventory of 6,545 switch engines. Omitting from consideration for small industrial yards, which typically do not have their own switch engines, the number of yards served by the 6,545 switch engines totals 2,618 yards. The overall average, therefore, is 2.5 switch engines per yard. This general factor is used to estimate costs and allocate the resulting estimates to the types of yards.

The basis for the unit cost used to quiet switch engines is the EPA document, Background Document for Railroad Noise Emission Standards, 1975. This document shows muffler costs ranging from $200 to $500 for the GM switchers and from $500 to $800 for other types of switch engines. To account for subsequent inflationary increases, the highest point of these ranges, $800 was used a general unit cost factor.

In addition to mufflers, the switch engines' cooling fans would be modified at an estimated cost of $400 each.

Switch engines in 1976 consumed 367,241,671[5] gallons of diesel fuel and the national inventory of switch engines for that year was 6,545 engines. This means an average annual consumption of 56,000 gallons of fuel per switch engine. At 32 cents per gallon, the annual fuel cost is $17,920 per year, per switch engine. A one to one and one half percent increase in fuel consumption would result in an incremental cost due to noise abatement of approximately $230 per year per engine.

Load Test Sites

A load test site typically includes a small structure to house instruments and resistors. Normally, locomotives are not sheltered when under load test. The noise abatement technique considered involves constructing an enclosure to contain the noise emanating from the locomotive being tested. An industrial type structure of 3,000 square feet should be adequate to enclose the locomotive. Construction costs of $30 per square foot[1] are used to estimate the cost of the structure. Estimating the construction cost of 3,000 square feet results in an estimate of $90,000 per structure. It is estimated that there are 216 load test sites in the U.S. railroad system and that the useful life of the enclosure is 30 years. The incremental cost of this procedure to the railroad industry is estimated to be:

Estimated Costs ($000)

Capital	Annualized	
19,440	2,061	(Capital Recovery)
	1,944	(Maintenance)

Relocation or Shut-Down of Idling Locomotives

No significant costs can be ascertained for relocating or shutting down idling locomotives, but there would be some savings in fuel expenses. However, there would be a counterbalancing expense if the locomotives cannot be restarted promptly when needed as well as some possibility of damage in restarting the engines during below freezing temperatures unless appropriate procedures are followed.

These types of expenses are difficult to determine; however, they do not appear to be of sufficient magnitude to be significant. Documents which present railroad operating costs, such as Guidebook for Planning to Alleviate Urban Railroad Problems, SRI, Aug. 1974, do not show idling locomotive costs.

Rescheduling Nighttime Activity

The purpose of this section is to discuss the method used to estimate the costs to the railroad industry if yard activities are curtailed from 2200 hours to 0700 hours. This curtailment is assumed to be necessary to achieve L_{dn} 65 for flat railyards and L_{dn} 60 for hump yard complexes.

The method assumes that railroad management would elimate third shift operations, except for skeleton crews to sustain yard utilities, and assign third shift personnel to first and second shift operations. The method also assumes that the normal first and second shifts are fully utilized during normal three shift operations. The introduction of fifty percent more personnel into each of these two "daytime" shifts would therefore require a fifty percent increase in yard equipment, etc., in order to achieve in two shifts, the yard throughput and productivity of normal three shift operations.

The number of available switch engines would therefore have to be increased by 50 percent. This results in an increase in the switch engine inventory of approximately 3,300 engines at a capital cost of \$176,000 each.[10] Further, many of the yard O&M expenses are assumed to increase by 50 percent. These include \$112,500,000 for maintenance of way and structures (50 percent of \$225M[9]), \$88,500,000 for maintenance of equipment (50 percent of \$177M[9]) and \$99,000,000 for transportation.- rail line costs (50 percent of \$198M[9]). The sum of these assumed increases in operations and maintenance costs is therefore \$300M.

This incremental cost estimate is now distributed to the 4,169 known railyards.[7] Engine costs are distributed at $176,000 capital costs annualized over 23 years and 10 percent at $19,840 per year. The $300M cost increase for O&M is distributed to specific yards according to yard annual volume and the number of yards of each major type.[7] The incremental cost increase for O&M is distributed as follows:

Yard Type	Number of Yards	Percent of Annual Car Volume	Total Incremental O&M Cost ($ M)	Incremental O&M Cost per Yard ($ K)
Hump	124	16	48	387
Flat Classification	1113	62	186	167
Industrial	1381	18	54	39
Small Industrial	1551	4	12	8
	4169	100	300	

The total incremental cost to the railroad industry resulting from the curtailment of yard operations from 2200 hours to 0700 hours is estimated to be:

Estimated Costs ($000)

Capital	Annualized	
576,614	64,926	(Capital Recovery)
	300,000	(Operations & Maintenance)
	$364,926	

The above estimates do not include the cost of several other problems which could result from the curtailment of night operations. For example, some of the current railyards may require physical expansion to maintain three shift throughput with only two shift operations. Rail service may also be adversely effected in certain areas due to yard or line bottlenecks and congestion. Service effects, which are negative, could result in the loss of business and revenue to water and motor carriers.

The railroad and railyard system does, however, possess a certain amount of inherent flexibility Railyard operations may be adjustable to produce an overall level of coordination which could increase line-haul activity at night and which could result in morning yard arrivals and afternoon yard departures. Further, industry and industrial yard interaction may be adjustable to a higher fraction of daylight service. Although the level of railroad, railyard, and customer flexibility cannot be quantified, without elaborate network modelling, the system is flexible within certain unknown limits.

The total incremental cost to the railroad industry resulting from the curtailment of yard operations from 2200 hours to 0700 hours is estimated to be:

Estimated Costs ($000)

Capital	Annualized	
576,614	64,926	(Capital Recovery)
	300,000	(Operations & Maintenance)
	$364,000	

The above estimates do not include the cost of several other problems which could result from the curtailment of night operations. For example, some of the current railyards may require physical expansion to maintain three shift throughput with only two shift operations. Rail service may also be adversely effected in certain areas due to yard or line bottlenecks and congestion. Service effects, which are negative, could result in the loss of business and revenue to water and motor carriers.

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Estimated Cost of Yard Noise Level Measurement

It is estimated that the labor involved in the measurement of railyard noise levels will vary from $500 to $2,000 per yard per year depending on yard size. Instrumentation costs, at $10,000 per set, and the purchase of approximately 590 sets by the railroad industry will result in a capital investment of $587M. The total incremental cost estimated to be associated with railyard noise measurement is therefore:

Estimated Costs ($000)

Capital	Annualized	Remarks
5,870	1,548	5 Year amortization
	587	Maintenance
	3,771	Labor
	$5,906	

These estimates are based upon the measurement of each railyard once each year and the purchase of one set of instrumentation for every twelve railyards owned by a particular railroad company.

REFERENCES

1. Background Document for Railroad Noise Emission Standards, U. S. EPA, Washington, D.C., Dec. 1975.
2. Private Communication, Mr. Rudy Nagal, Signal Dept., Southern Pacific Railroad, April 3, 1978.
3. Calculated from Background Docment for Railroad Noise Emission Standards, Appendix C, U.S. EPA, Dec. 1975.
4. Estimate received in discussions with members of the AAR's Research and Test Department on 31 March 1978.
5. Statistics of Railroads-Class I, Year 1966-1976, American Association of Railroads, Dec. 1977.
6. The basis of the construction cost estimates is Building Construction Cost Data, Means, Duxburg, Mass. (1976).
7. Railroad Classification Yard Technology, SRI, Menlo Park, 1977.
8. "Cost Impact Analysis of Prepared Noise Regulation for Truck Mounted Refirgerator Units", A. T. Kearney, Inc., Chicago, Illinois, (undated).
9. Transport Statistics in the United States, Part 1 Railroads, ICC, 31 December 1975.
10. Intercity Domestic Transportation System for Passengers and Freight, Committee on Commerce, Science, and Transportation, U. S. Government Printing Office, 1977

APPENDIX D

SUPPORTING MATERIALS RELATED TO THE LAND ACQUISITION OPTION

APPENDIX D

SUPPORTING MATERIALS RELATED TO THE LAND ACQUISITION OPTION

This section contains supporting materials related to the option of land acquisition for noise abatement. The acquisition of land represents an alternative strategy to the application of noise abatement procedures to noise sources within yards that the railroad industry could use to meet the various noise regulatory study levels.

- Distribution of Land Beyond Yards by Land Use

  Percentage of land outside the railyards within the specified contour surrounding the yards by land use categories. These categories are residential, commercial, industrial, agricultural and undeveloped; designations (alpha code) for land use shown in the tabularized array are R, C, I, A, and U, respectively. Table 1 displays percentages for the land use categories as a function of yard type and place size for all yards which were analyzed.

  Based on the sample data contained within each element of the matrix, Table 2 was developed to represent the land use distribution around a typical yard for each matrix element (yard type by place size). The content of elements (percentages of the categories of land use for a typical yard) were used directly in the computation of land acquisition costs.

- Estimated Costs of Land by Land Use Categories

  Acquiring the land surrounding noise sources located within a railroad yard can be used with, or as an alternative to, technologically induced noise level reduction. The land would be acquired in such a pattern that the noise levels at the perimeter of yard-owned lands would conform with the proposed regulation.

  To estimate the compliance costs to the railroads of acquiring the land surrounding their yards, an average price per square foot was determined for each of the five major land uses: residential, commercial, industrial, agricultural and undeveloped. These prices are as follows:

Land Use	1978 price/sq.ft.
Residential	
Single family units	4.84[1]
Multi-family units	30.45
Commercial	3.51
Industrial	1.66
Agricultural	0.014
Undeveloped	0.014

[1] Includes structure and property.

The sources used to estimate these prices were:

Economic News Notes, National Association of Homebuilders, May 1978.

Historical Analysis of Unit Land Prices, Real Estate Research Corporation, 1973.

Farm Real Estate Market Developments, Economies, Statistics & Cooperatives Service, U. S. Department of Agriculture, July 1978.

The single family unit price per square foot was determined from the NAHB data by:

1. Dividing the 1977 sales price by the average size of lot
2. Inflating the resulting price/sq. ft. to 1978 values by applying an inflation rate of 10 percent per year.

The multi-family unit price per square foot was established as follows:

1. The Real Estate Research Corporation data on residential prices were inflated from 1973 to 1978 values by applying an assumed inflation rate of 10 percent per year.
2. The ratio between sales prices listed by NAHB and RERC for single family units was calculated and applied to the inflated RERC data to determine the 1977 average sales price. An identical procedure is used to calculated the average size of a lot for multi-unit dwellings.
3. The 1977 average sales price was inflated to 1978 values and divided by the average size of lot.

TABLE 1

PERCENT OF RAILROAD YARD BY LAND USE CATEGORIES

YT POP	R	C	A	I	U	YT POP	R	C	A	I	U	YT POP	R	C	A	I	U
11	68	16	0	26	131	12	41	9	52	79	128	13	25	11	0	17	115
11	79	18	0	32	17	12	100	82	0	67	33	13	78	69	0	162	0
11	30	2	13	2	184	12	148	36	9	90	90	13	86	18	0	42	20
11	119	58	76	100	107	12	95	4	0	19	201	13	56	0	0	42	51
11	142	7	57	31	131	12	150	49	32	81	44	13	34	0	11	34	65
11	42	18	36	10	125	12	12	0	40	29	174	13	89	7	64	45	7
11	55	2	66	82	32	12	75	5	115	23	112	13	155	31	0	36	0
11	195	17	0	71	39	12	152	110	0	93	59	13	27	0	129	25	9
11	32	0	9	49	150	12	23	20	174	24	66	13	4	4	13	44	35
11	75	4	80	77	61	12	11	17	0	153	238						
21	62	32	3	68	44	22	33	28	0	35	2	23	45	23	0	97	0
21	112	22	19	8	25	22	49	17	14	21	80	23	125	20	0	84	0
21	86	4	0	33	103	22	63	7	0	9	121	23	21	6	2	61	43
21	36	14	43	2	9	22	46	20	0	26	25	23	30	32	31	58	32
21	43	0	6	27	48	22	58	21	10	33	11	23	0	0	0	110	57
21	19	0	40	13	50	22	65	0	0	48	18	23	100	14	0	8	8
21	61	28	41	0	71	22	32	16	27	0	18	23	57	113	0	120	9
21	17	2	0	2	0	22	29	0	61	0	75	23	30	1	42	1	35
21	16	6	0	3	1	22	62	7	0	81	19	23	30	5	7	56	67
12	46	21	68	3	5	22	10	5	69	0	15	23	78	39	0	17	0

Legend:

YT POP = Yard Type and Place Size
11; 12; 13 = Hump Yards in Place sizes of 50,000 population; 50-250,000
1
31
41

TABLE 1 (Continued)

PERCENT OF RAILROAD YARD BY LAND USE CATEGORIES

YT POP	R	C	A	I	U	YT POP	R	C	A	I	U	YT POP	R	C	A	I	U
31	6	0	0	16	38	32	71	17	0	23	5	33	53	70	0	67	10
31	73	17	0	23	89	32	33	57	0	24	4	33	23	14	0	13	41
31	8	0	4	146	65	32	63	0	0	36	3	33	30	7	0	58	0
31	10	0	147	0	44	32	46	26	12	24	30	33	23	2	0	42	14
31	3	0	0	83	0	32	79	8	0	42	2	33	16	58	0	29	0
31	86	28	6	67	33	32	31	13	0	9	26	33	45	36	0	18	1
31	48	25	24	0	20	32	73	29	0	13	13	33	34	45	0	107	1
31	54	8	19	4	45	32	75	1	0	5	0	33	35	29	0	24	0
31	5	2	20	50	75	32	23	28	0	29	0	33	2	0	0	53	53
31	45	6	0	35	30	32	30	43	0	26	1	33	29	14	0	35	43
41	46	9	33	2	7	42	11	10	0	15	40	43	21	18	0	23	95
41	3	0	95	4	0	42	35	0	0	44	4	43	2	2	0	69	0
41	7	0	4	0	8	42	11	25	3	53	10	43	121	25	0	9	5
41	26	65	0	6	0	42	56	13	0	49	113	43	48	24	0	97	8
41	51	6	0	25	46	42	73	13	0	9	28	43	11	28	0	9	17
41	51	33	0	9	11	42	12	7	0	40	25	43	48	9	0	68	0
41	9	0	0	0	8	42	20	18	48	10	6	43	29	9	0	59	7
41	15	9	5	37	29	42	77	24	0	27	18	43	25	7	0	34	14
41	34	19	11	21	13	42	16	11	0	84	7	43	13	1	0	73	0
41	0	0	5	18	40							43	6	31	0	38	20

Legend:

YT POP = Yard Type and Place Size
11; 12; 13 = Hump Yards in Place sizes of 50,000 population; 50-250,000
1
31
41

TABLE 2

RAILROAD YARD LANDUSE SUMMARY (PERCENTAGE)

Yard Type	Land Use Code	Place Size							
		POP. <50K		POP. 50-250K		POP. 250+K		ALL POP.	
		Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance
Hump	R	30	16	23	15	28	19	27	17
	C	5	5	10	11	7	7	7	8
	A	11	11	14	19	13	23	13	17
	I	17	11	19	10	24	15	20	12
	U	37	24	35	22	27	26	33	24
Flat Class.	R	42	20	32	12	31	24	35	19
	C	10	8	10	9	13	12	11	10
	A	16	18	15	23	6	13	12	19
	I	11	10	18	18	33	21	21	19
	U	21	18	24	19	17	17	21	17
Flat Ind.	R	22	18	49	21	26	12	32	21
	C	5	7	21	17	22	18	16	16
	A	12	23	1	3	0	0	4	14
	I	30	30	21	11	37	16	30	21
	U	30	19	8	11	15	20	18	19
Flat S/Ind.	R	31	19	28	19	25	21	28	19
	C	14	21	12	7	14	13	14	15
	A	17	29	6	16	0	0	8	20
	I	13	13	33	23	46	29	31	26
	U	25	22	21	19	14	19	20	20
All Yard Types	R	31	19	33	19	28	19	31	19
	C	9	12	13	12	14	14	12	13
	A	14	21	9	17	5	13	9	18
	I	18	19	23	16	35	22	25	21
	U	28	21	22	20	18	20	23	21

The prices per square foot for commercial and industrial land uses were calculated as an average of the inflated price ranges listed by the RERC data. (1973 data was inflated at a 10 percent rate to 1978 values.)

The U. S. Department of Agriculture's average price per acre of voluntary and estate sales for the 48 continental states was used and divided by the number of square feet in an acre to obtain the average price per square foot.

Due to the low value of agricultural land, the price per square foot of undeveloped land was assumed to be equivalent.

- Distribution of Residential Land Between Single & Multiple Dwelling Units

Based upon an analysis of 1970 Census data acquired through the Bureau of Census, Department of Commerce, pertaining to census tract data related to each of the sampled yard populations (universe), information was derived for the estimation of single and multiple dwelling units. The estimates made were in percentages representing the weighted averages of residential land distributed between such units for each of the 12 cells comprising the matrix of yard types and place size. Table 3 displays the data results of the analysis in terms of the weighted averages (percentages) for each cell of this matrix.

TABLE 3

PERCENT DISTRIBUTION OF SINGLE & MULTIPLE DWELLING UNITS RELATED TO THE MATRIX OF TYPE OF YARD AND PLACE SIZE

Type of Yard	50K Dwelling Units Single	Multiple	50K - 250K Dwelling Units Single	Multiple	250K Dwelling Units Single	Multiple
Hump	83	17	78	22	63	37
Flat	87	13	64	36	60	40
Ind.	70	30	56	44	47	53
Sm. Ind.	92	8	77	23	54	46

- Estimated Annual Owning Expenses for Various Real Estate Categories

In addition to the purchasing or capital cost, railroad companies would incur certain annual recurring costs as a result of real estate ownership. Annual costs would include interest payments, insurance and property taxes. Interest payments, as derived from current industrial bond rates, would amount to approximately 10 percent per year. An additional 1 percent would be required on the average for insurance payments. An additional 2 percent[1] of the purchase price (i.e. market value) would be required for property taxes. These expenses are listed in the following tabulation:

Estimated Annual Owning Expenses for Real Estate

Interest Payment	10% of market value
Insurance	1%
Property Taxes	2%
	13%

- Calculated Areas Beyond Yard Property-Line by Yard Type and Place Size for Various Regulatory Study Levels

  Table 4 consists of 3 parts, labelled A, B, and C, to indicate the calculated areas contained within selected noise level contours beyond yard property lines by type of yard. The designated numbers of place size (1, 2, & 3) relate to populations less than 50K, 50-250K, >250K respectively. Parts A and B relate to hump and flat classification yards respectively, while Part C of Table 4 includes industrial and small industrial yards. The first row of data contained in Parts A and B relates to the baseline noise level and calculated areas as a function of place size and yard activity levels (low, medium, and high). The areas contained within contours were calculated and the results are displayed for various noise regulatory levels. The remaining rows of both Parts A and B specify the total areas within noise level contours resulting from reducing the noise at the yard property lines through application of noise abatement procedures (technology fixes, as previously described in Sections 5 and 7) to meet the regulatory study levels of L_{dn} 75, 65 or 60. Table 4, Part C is formatted in a similar way, but differs slightly resulting from use of one level of activity. It should be noted also that yard property line reduction does not have an impact on these yards until L_{dn} 70 is used.

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[1] Taxable Property Values and Assessment Sales Price Ratios, 1972 Census of Governments, Part 2, U.S. Department of Commerce, 1973.

TABLE 4(A)

AREAS (x10^6 sq. ft.) WITHIN VARIOUS NOISE LEVEL CONTOURS, INCLUDING BASELINE AND REDUCTION OF YARD PROPERTY LINE LEVELS THROUGH EMPLOYMENT OF NOISE CONTROL AT VARIOUS REGULATORY STUDY LEVELS

	L_{dn} 75			L_{dn} 70			L_{dn} 65			L_{dn} 60			L_{dn} 55		
	Place Size			Place Size			Place Size			Place Size			Place Size		
Volume	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Hump Baseline															
(1) Low	30	24	19	158	125	100	683	540	419	1,970	1,555	1,160	4,145	3,272	2,349
(2) Medium	41	24	31	290	167	223	1,197	694	894	3,300	1,910	2,364	6,366	3,685	4,384
(3) High	85	48	49	426	242	245	1,505	860	835	3,435	2,826	1,832	6,058	4,902	3,130
TOTAL	156	96	99	874	534	568	3,385	2,094	2,148	8,705	6,291	5,356	16,569	11,859	9,863
Hump SL 75															
1 L	0	0	0	80	63	52	492	389	306	1,586	1,252	944	3,504	2,767	1,990
2 M	0	0	0	167	97	133	921	534	697	2,808	1,626	2,021	5,602	3,243	3,864
3 H	0	0	0	217	124	129	1,035	592	585	2,698	1,541	1,453	5,021	2,868	2,607
TOTAL	0	0	0	464	284	314	2,448	1,515	1,588	7,092	4,459	4,418	14,127	8,878	8,461
Hump SL 70															
1 L	0	0	0	0	0	0	220	173	141	1,047	827	637	2,660	2,100	1,538
2 M	0	0	0	0	0	0	365	212	286	1,667	965	1,237	3,947	2,285	2,786
3 H	0	0	0	0	0	0	323	185	191	1,435	1,193	780	3,211	1,835	1,714
TOTAL	0	0	0	0	0	0	908	570	618	4,149	2,985	2,654	9,818	6,220	6,038
Hump SL 65															
1 L	0	0	0	0	0	0	0	0	0	286	226	182	1,286	1,016	777
2 M	0	0	0	0	0	0	0	0	0	365	212	286	1,667	965	1,237
3 H	0	0	0	0	0	0	0	0	0	323	185	191	1,394	797	780
TOTAL	0	0	0	0	0	0	0	0	0	974	623	659	4,347	2,778	2,794
Hump SL 60															
1 L	0	0	0	0	0	0	0	0	0	0	0	0	286	226	182
2 M	0	0	0	0	0	0	0	0	0	0	0	0	365	211	286
3 H	0	0	0	0	0	0	0	0	0	0	0	0	323	185	191
TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	974	622	659

TABLE 4(B)

		L_{dn} 75			L_{dn} 70			L_{dn} 65			L_{dn} 60			L_{dn} 55		
		Place Size			Place Size			Place Size			Place Size			Place Size		
Volume		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Flat Baseline																
1	L	6	3	2	102	43	35	2,310	972	780	11,451	4,972	3,772	28,140	11,834	8,602
2	M	29	12	10	1,409	573	458	6,376	2,594	1,976	17,453	7,101	5,143	34,240	13,931	9,682
3	H	41	17	13	759	321	246	5,321	2,251	1,656	14,649	6,198	4,347	28,278	11,963	8,073
TOTAL		76	32	25	2,270	937	739	14,007	5,817	4,412	43,533	18,271	13,262	62,380	37,728	26,357
SL 75	L	0	0	0	67	28	23	2,169	912	734	11,328	4,764	3,636	27,247	11,458	8,328
	M	0	0	0	1,288	524	419	5,890	2,397	1,824	15,995	6,508	4,706	31,153	12,675	8,805
	H	0	0	0	568	241	187	4,573	1,935	5,176	12,844	5,455	3,853	24,945	10,553	7,187
TOTAL		0	0	0	1,923	793	629	12,532	5,244	7,734	40,217	16,727	12,195	83,345	24,122	24,320
SL 70	L	0	0	0	0	0	0	1,904	801	645	10,153	4,270	3,257	134,132	10,149	7,367
	M	0	0	0	0	0	0	1,480	602	480	6,637	2,700	2,045	17,129	6,969	5,018
	H	0	0	0	0	0	0	2,618	1,107	833	9,484	4,013	2,872	19,770	8,365	5,756
TOTAL		0	0	0	0	0	0	6,002	2,510	1,958	26,274	10,983	8,174	171,031	25,483	18,141
SL 65	L	0	0	0	0	0	0	0	0	0	1,905	801	645	10,153	4,270	3,256
	M	0	0	0	0	0	0	0	0	0	1,480	602	480	6,637	2,700	2,045
	H	0	0	0	0	0	0	0	0	0	21,718	1,107	833	1,473	4,007	1,867
TOTAL		0	0	0	0	0	0	0	0	0	25,103	2,510	1,313	26,263	10,977	8,168
SL 60	L	0	0	0	0	0	0	0	0	0	0	0	0	1,905	801	645
	M	0	0	0	0	0	0	0	0	0	0	0	0	1,480	602	480
	H	0	0	0	0	0	0	0	0	0	0	0	0	2,618	1,107	833
TOTAL		0	0	0	0	0	0	0	0	0	0	0	0	6,003	2,510	1,958

TABLE 4(C)

	L_{dn} 65			L_{dn} 60			L_{dn} 55		
	Place Size			Place Size			Place Size		
Volume	1	2	3	1	2	3	1	2	3
Flat Ind. Baseline									
1) Low	11,294	3,180	3,558	36,000	10,134	10,654	76,114	21,426	21,242
Level 65	-	-	-	1,538	4,330	4,792	4,384	12,342	12,840
Level 60	-	-	-	-	-	-	15,728	4,428	4,904
Sm. Ind. Baseline	-	-	-	13,994	1,474	1,588	40,830	4,304	4,358
Level 60	-	-	-	-	-	-	14,332	1,510	1,630

TABLE 4(A)

AREAS* WITHIN VARIOUS NOISE LEVEL CONTOURS, INCLUDING BASELINE AND REDUCTION OF YARD PROPERTY LINE LEVELS THROUGH EMPLOYMENT OF NOISE CONTROL AT VARIOUS REGULATORY STUDY LEVELS

	L_{dn} 75			L_{dn} 70			L_{dn} 65			L_{dn} 60			L_{dn} 55		
	Place Size			Place Size			Place Size			Place Size			Place Size		
Volume	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Hump Baseline															
(1) Low	30	24	19	158	125	100	683	540	419	1,970	1,555	1,160	4,145	3,272	2,349
(2) Medium	41	24	31	290	167	223	1,197	694	894	3,300	1,910	2,364	6,366	3,685	4,384
(3) High	85	48	49	426	242	245	1,505	860	835	3,435	2,826	1,832	6,058	4,902	3,130
TOTAL	156	96	99	874	534	568	3,385	2,094	2,148	8,705	6,291	5,356	16,569	11,859	9,863
Hump SL 75															
1 L	0	0	0	80	63	52	492	389	306	1,586	1,252	944	3,504	2,767	1,990
2 M	0	0	0	167	97	133	921	534	697	2,808	1,626	2,021	5,602	3,243	3,864
3 H	0	0	0	217	124	129	1,035	592	585	2,698	1,541	1,453	5,021	2,868	2,607
TOTAL	0	0	0	464	284	314	2,448	1,515	1,588	7,092	4,459	4,418	14,127	8,878	8,461
Hump SL 70															
1 L	0	0	0	0	0	0	220	173	141	1,047	827	637	2,660	2,100	1,538
2 M	0	0	0	0	0	0	365	212	286	1,667	965	1,237	3,947	2,285	2,786
3 H	0	0	0	0	0	0	323	185	191	1,435	1,193	780	3,211	1,835	1,714
TOTAL	0	0	0	0	0	0	908	570	618	4,149	2,985	2,654	9,818	6,220	6,038
Hump SL 65															
1 L	0	0	0	0	0	0	0	0	0	286	226	182	1,286	1,016	777
2 M	0	0	0	0	0	0	0	0	0	365	212	286	1,667	965	1,237
3 H	0	0	0	0	0	0	0	0	0	323	185	191	1,394	797	780
TOTAL	0	0	0	0	0	0	0	0	0	974	623	659	4,347	2,778	2,794
Hump SL 60															
1 L	0	0	0	0	0	0	0	0	0	0	0	0	286	226	182
2 M	0	0	0	0	0	0	0	0	0	0	0	0	365	211	286
3 H	0	0	0	0	0	0	0	0	0	0	0	0	323	185	191
TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	974	622	659

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* 10^6 Sq. Ft.

TABLE 4(B)

		L_{dn} 75			L_{dn} 70			L_{dn} 65			L_{dn} 60			L_{dn} 55		
		Place Size			Place Size			Place Size			Place Size			Place Size		
Volume		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Flat Baseline																
1	L	6	3	2	102	43	35	2,310	972	780	11,451	4,972	3,772	28,140	11,834	8,602
2	M	29	12	10	1,409	573	458	6,376	2,594	1,976	17,453	7,101	5,143	34,240	13,931	9,682
3	H	41	17	13	759	321	246	5,321	2,251	1,656	14,649	6,198	4,347	28,278	11,963	8,073
TOTAL		76	32	25	2,270	937	739	14,007	5,817	4,412	43,533	18,271	13,262	62,380	37,728	26,357
SL 75	L	0	0	0	67	28	23	2,169	912	734	11,328	4,764	3,636	27,247	11,458	8,328
	M	0	0	0	1,288	524	419	5,890	2,397	1,824	15,995	6,508	4,706	31,153	12,675	8,805
	H	0	0	0	568	241	187	4,573	1,935	5,176	12,844	5,455	3,853	24,945	10,553	7,187
TOTAL		0	0	0	1,923	793	629	12,632	5,244	7,734	40,217	16,727	12,195	83,345	24,122	24,320
SL 70	L	0	0	0	0	0	0	1,904	801	645	10,153	4,270	3,257	134,132	10,149	7,367
	M	0	0	0	0	0	0	1,480	602	480	6,637	2,700	2,045	17,129	6,969	5,018
	H	0	0	0	0	0	0	2,618	1,107	833	9,484	4,013	2,872	19,770	8,365	5,756
TOTAL		0	0	0	0	0	0	6,002	2,510	1,958	26,274	10,983	8,174	171,031	25,483	18,141
SL 65	L	0	0	0	0	0	0	0	0	0	1,905	801	645	10,153	4,270	3,256
	M	0	0	0	0	0	0	0	0	0	1,480	602	480	6,637	2,700	2,045
	H	0	0	0	0	0	0	0	0	0	21,718	1,107	833	1,473	4,007	1,867
TOTAL		0	0	0	0	0	0	0	0	0	25,103	2,510	1,313	26,263	10,977	8,168
SL 60	L	0	0	0	0	0	0	0	0	0	0	0	0	1,905	801	645
	M	0	0	0	0	0	0	0	0	0	0	0	0	1,480	602	480
	H	0	0	0	0	0	0	0	0	0	0	0	0	2,618	1,107	833
TOTAL		0	0	0	0	0	0	0	0	0	0	0	0	6,003	2,510	1,958

TABLE 4(C)

	L_{dn} 65			L_{dn} 60			L_{dn} 55		
	Place Size			Place Size			Place Size		
Volume	1	2	3	1	2	3	1	2	3
Flat Ind. Baseline									
1) Low	11,294	3,180	3,558	36,000	10,134	10,654	76,114	21,426	21,242
Level 65	-	-	-	1,538	4,330	4,792	4,384	12,342	12,840
Level 60	-	-	-	-	-	-	15,728	4,428	4,904
Sm. Ind. Baseline	-	-	-	13,994	1,474	1,588	40,830	4,304	4,358
Level 60	-	-	-	-	-	-	14,332	1,510	1,630

APPENDIX E

TABULATION OF RAILROAD COMPANIES STUDIED INCLUDING NUMBER OF YARDS OWNED AND COMPANY OWNERSHIP

Road Name	Number of Yards Owned	Ownership
Aberdeen & Rockfish	1	Independent
Akron & Barberton Belt	2	Baltimore & Ohio RR Company; Canton & Youngstown RR Co.; Conrail
Akron, Canton & Youngstown	3	Norfolk & Western Ry. Co.
Alameda Belt Line	1	Aff. with Western Pacific
Aliquippa & Southern	2	Jones & Laughlin Steel Corp.
Alton & Southern	1	St. Louis Southwestern & Missouri Pacific
Angelina & Neches River	2	Southland Paper Mills, Inc.
Ann Arbor	4	Detroit, Toledo & Ironton
Apache	1	Southern Forest Ind., Inc.
Apalachicola Northern	2	St. Joe Paper Company
Arcade & Attica	1	Independent
Arcata & Mad River	1	Simpson Timber Company
Arkansas & Louisiana Missouri	2	Olinkraft, Inc.
Aroostock Valley	1	Canadian Pacific, Ltd.
Ashley, Drew & Northern	1	Independent
Atchison, Topeka & Santa Fe	173	Santa Fe Ind., Inc.
Atlanta & St. Andrews Bay	5	International Paper
Atlanta & West Point	2	Seaboard Coast Line RR Co.
Baltimore & Ohio	181	Chesapeake & Ohio Ry. Co.
Baltimore & Ohio Chicago Terminal	9	Baltimore & Ohio RR Co.
Bangor & Aroostook	6	Amoskeag Co.
Bauxite & Northern	1	Aluminum Company of America
Belfast & Moosehead Lake	1	City of Belfast, Maine
Belt Ry. Company of Chicago	[illegible]	Various RR Companies
Bessemer & Lake Erie	[illegible]	U. S. Steel Corporation
Birmingham Southern	[illegible]	U. S. Steel Corporation
Boston & Maine	[illegible]	[illegible]
Brooklyn Eastern Dist. Terminal	1	Independent
Burlington Northern	[illegible]	Independent
Butte, Anaconda & Pacific	[illegible]	Anaconda Company

Road Name	Number of Yards Owned	Ownership
Cadiz	1	USRA and Stockholders
California Western	1	Georgia Pacific Corporation
Cambria & Indiana	2	Bethlehem Steel Corporation
Camino, Placerville & Lake Tahoe	2	Michigan-California Lumber Co.
Canadian National	3	Independent
Canton	1	Canton Company of Baltimore (sub. of Int'l. Mining Corp.)
Carolina & Northwestern (Norfolk Southern)	1	Southern Ry. Company
Carrollton	1	Louisville & Nashville; Seaboard Coast Line
Central California Traction	1	Southern Pacific; Atchison, Topeka & Santa Fe; Western Pacific
Central of Georgia	30	Southern Ry. Company
Central RR Company of New Jersey	13	Reading Company
Central Vermont	6	Grand Trunk Corporation
Chattahoochee Valley	2	West Point-Pepperill, Inc.
Chesapeake & Ohio	113	Chessie System, Inc.
Chesapeake Western	1	Norfolk & Western Ry. Co.
Chicago & Illinois Midland	6	Commonwealth Edison Company
Chicago & Illinois Western	1	DC Ind., Inc.
Chicago & Northwestern	154	Independent
Chicago, Milwaukee, St. Paul & Pacific	165	Chicago Milwaukee Corporation
Chicago River & Indiana	5	Penn Central Trans. Company
Chicago, Rock Island & Pacific	133	Independent
Chicago Short Line	1	Independent
Chicago South Shore & South Bend	1	Chesapeake & Ohio RR
Cincinnati, New Orleans & Texas Pac.	2	Southern Ry. Co.
City of Prineville	1	Independent
Clarendon & Pittsford	1	Vermont Marble Company
Cliffside	1	Cone Mills Corporation

Road Name	Number of Yards Owned	Ownership
Colorado & Southern	12	Burlington Northern, Inc.
Colorado & Wyoming	2	CR&L Steel Corporation
Conrail	1	USRA and Stockholders
Cuyahoga Valley	1	Jones & Laughlin Steel Corp.
Dansville & Mount Morris	1	Independent
Dardanelle & Russellville	1	McAlister Fuel Company
Davenport, Rock Island & North-western	1	Burlington Northern, Inc.; Chicago, Milwaukee, St. Paul & Pacific RR Company
Delaware & Hudson	23	Dereco-Norfolk & Western
Delta Valley & Southern	1	Independent
Denver & Rio Grande Western	30	Rio Grande Ind., Inc.
DeQueen & Eastern	2	Weyerhauser Company
Des Moines Union	1	Norfolk & Western Ry. Co.; Chicago, Milwaukee, St. Paul & Pacific RR Company
Detroit & Mackinac	4	Independent
Detroit & Toledo Shoreline	2	Grand Trunk Western RR Co.; Norfolk & Western Ry. Company
Detroit Terminal	2	Penn Central Trans. Company; Grand Trunk; Michigan Central RR
Detroit, Toledo & Ironton	13	Penn Central Trans. System
Duluth, Missabe & Iron Range	9	U. S. Steel Corporation
Duluth, Winnipeg & Pacific	1	Grand Trunk Corporation
Durham & Southern	3	Seaboard Coast Line RR Co.
Eldorado & Wesson	1	Independent
Elgin, Joliet & Eastern	13	U. S. Steel Corporation
Erie Lackawanna	91	Dereco-Norfolk & Western
Escanaba & Lake Superior	1	Independent

Road Name	Number of Yards Owned	Ownership
Fairport, Painesville & Eastern	2	Penn Central; Norfolk & Western Ry.
Florida East Coast	9	Independent
Fonda, Johnstown & Gloversville	1	Delaware Obego Corporation
Fordyce & Princeton	1	Georgia-Pacific Corporation
Fort Worth & Denver	10	Colorado & Southern; Burlington Northern, Inc., System
Fort Worth Belt	1	Missouri-Pacific RR Company
Gainesville Midland	1	Seaboard Coast Line RR Co.
Galveston, Houston & Henderson	5	Missouri-Kansas-Texas; Missouri-Pacific
Garden City Western	1	Garden City Company
Genessee & Wyoming	1	Independent
Georgia	7	Seaboard Coast Line
Grafton & Upton	1	Rockwell Int'l. Corporation
Grand Trunk Western	24	Grand Trunk Corporation (sub. of Canadian Nat'l. Ry. Co.)
Graysonia, Nashville & Ashdown	1	Independent
Great Western	1	Great Western Sugar Company (sub. of Great Western United Corporation)
Green Bay & Western	5	Independent
Greenwich & Johnsonville	1	Delaware & Hudson Ry. Company
Hartwell	1	Independent
High Point, Thomasville, & Denton	1	Winston-Salem Southbound Ry. Co.
Illinois Central Gulf	132	IC Ind., Inc.
Illinois Terminal	8	Independent
Indiana Harbor Belt	11	Conrail

Road Name	Number of Yards Owned	Ownership
Kansas City Terminal	1	Twelve RR Companies
Kentucky & Indiana Terminal	5	Independent
Lackawanna & Wyoming Valley	2	Erie Lackawanna Ry. Company
Lake Erie & Ft. Wayne	1	Norfolk & Western Ry. Company
Lake Erie, Franklin & Clarion	1	Independent
Lake Front Dock & RR Terminal	1	Penn Central; Baltimore & Ohio
Lake Superior & Ishpeming	5	Cleveland Cliffs Iron Company
Lake Superior Terminal & Transfer	1	B.N.; Chicago & Northwestern; Soo Line
Lake Terminal	2	U. S. Steel Corporation
Lancaster & Chester	1	H. W. Close, et al., Trustees
Laurinburg & Southern	1	Independent
Lehigh Valley	34	Penn Central
Long Island	4	Metro. Trans. Auth., New York
Los Angeles Junction	1	Atchison, Topeka & Santa Fe
Louisiana & Arkansas	8	Kansas City Southern Ry. Co.
Louisiana & Northwest	1	H. E. Salzberg Company
Louisiana & Pine Bluff	1	Olinkraft, Inc.
Louisville & Nashville	111	Seaboard Coast Line RR Company
Louisville & Wadley	1	Independent
Louisville, New Albany & Corydon	1	Independent
Maine Central	8	Independent
Magma Arizona	1	Magma Copper Company
Manufacturers Junction	1	Western Electric Co., Inc.
Massena Terminal	1	Aluminum Company of America
McCloud River	1	Champion International Corp.
Meridian & Bigbee	6	American Can Company
Minneapolis, Northfield & Southern	6	Independent
Minnesota, Dakota & Western	1	Boise Cascade Corporation

Road Name	Number of Yards Owned	Ownership
Minnesota Transfer	1	Burlington Northern; Chicago, Milwaukee, St. Paul & Pacific RR; Chicago & Northwestern Trans. Co.; Chicago, Rock Island & Pacific RR; Soo Line
Mississippian	1	Independent
Mississippi Export	2	Independent
Missouri-Illinois	4	Missouri Pacific RR Company
Missouri-Kansas-Texas	33	Katy Ind., Inc.
Missouri Pacific	135	Missouri Pacific Corporation
Mobile & Gulf	1	James Graham Brown Foundation, Inc.
Monongahela	6	Penn Central; Baltimore & Ohio; Pittsburgh & Lake Erie
Monongahela Connecting	1	Jones & Laughlin Steel Corp.
Montour	2	Pittsburgh & Lake Erie RR Co.
Morristown & Erie	1	Subsidiary of Whippany Dev. Co. & ME Associates
Moscow, Camden & San Augustine	1	Independent
Moshassuck Valley	1	Independent
Mount Hood	1	100% Subsidiary of Union Pacific
Nevada Northern	4	Kennecott Coper Company
Newburgh & South Shore	3	U. S. Steel Corporation
New Orleans & Lower Coast	2	Missouri Pacific RR Company
New York Dock	1	Subsidiary of NYD Properties, Inc.
New York, Susquehanna & Western	3	Tri-Terminal Corporation
Norfolk, Franklin & Danville	2	Norfolk & Western Ry. Company
Norfolk & Portsmouth Belt Line	3	Seaboard Coast Line (four other RRs)
Norfolk Southern	9	Southern Ry. Company
Norfolk & Western	180	Independent
North Louisiana & Gulf	2	Continental Group, Inc.
Northwestern Pacific	7	Southern Pacific Trans. Company

Road Name	Number of Yards Owned	Ownership
Oakland Terminal	1	Western Pacific; Atchison, Topeka & Santa Fe
Pecos Valley Southern	1	Independent
Penn Central Trans. Company	567	Penn Central Company
Pennsylvania, Reading Seashore Lines	14	Penn Central Company
Peoria & Pekin Union Ry. Co.	5	Independent
Pittsburgh & Lake Erie	16	Penn Central Company
Pittsburgh & Ohio Valley	1	Shenango, Inc.
Pittsburgh, Chartiers & Youghiogheny	3	Conrail; Pittsburgh & Lake Erie
Port Huron & Detroit	1	Independent
Portland Terminal	2	B.N.; Oregon & Washington RR & Nav. Co.; Southern Pacific
Prescott & Northwestern	1	Potlatch Corporation
Providence & Worcester	2	Independent
Quanah, Acme & Pacific	2	St. Louis-S.F. Ry. Company
Quincy	1	Sierra Pacific Ind.
Rahway Valley	1	Independent
Reading	47	Conrail
Richmond, Fredericksburg & Potomac	4	Richmond-Washington Company
River Terminal	5	St. Paul Iron Mining Company (subsidiary of Republic Steel Corporation)
Roscoe, Snyder & Pacific	1	Independent

Road Name	Number of Yards Owned	Ownership
Saint Joseph Terminal	1	Atchison, Topeka & Santa Fe St. Joseph Grand Island Ry. Co.
Saint Louis-San Francisco	76	Independent
Saint Louis Southwestern	22	Southern Pacific Trans. Company
Saint Marys	2	Gilman Paper Company
Salt Lake, Garfield & Western	1	Hagle Assoc.
San Diego & Arizona Eastern	1	Southern Pacific Trans. Co.
Sand Springs	1	Sand Springs Home
San Luis Central	1	Pea Vine Corporation
Santa Maria Valley	3	Estate of G. Allan Hancock
Seaboard Coast Line	180	Seaboard Coast Line Ind., Inc.
Sierra	1	Independent
Soo Line	44	Canadian Pacific, Ltd.
Southern	144	Independent
Southern Pacific	211	Southern Pacific Company
Southern San Luis Valley	1	Messrs. G. M. Oringdulph and H. Quiller
Spokane International	5	Union Pacific RR Company
Springfield Terminal (Vermont)	1	Boston & Main Corporation
Staten Island RR Corporation	2	Baltimore & Ohio RR Company
Stockton Terminal & Eastern	1	Stockton Terminal & Eastern RR Company
Terminal RR Assn. of St. Louis	8	Various RR Companies
Texas and Northern	1	Lone Star Steel Company
Texas City Terminal	2	Missouri-Kansas-Texas RR; Missouri-Pacific RR Company; Atchison, Topeka & Santa Fe
Texas Mexican	3	Manufacturers Hanover Trust Company
Texas-New Mexico	1	Missouri Pacific RR Company
Texas South-Eastern	1	Independent
Toledo, Angola & Western	1	Medusa Corporation

Road Name	Number of Yards Owned	Ownership
Toledo, Peoria & Western	7	Atchison, Topeka & Santa Fe; Penn Central
Toledo Terminal	3	Conrail; Chesapeake & Ohio; Baltimore & Ohio; Norfolk & Western
Trona	1	Kerr McGee Chemical Corporation
Tucson, Cornelia & Gila Bend	1	Independent
Union Pacific	136	Union Pacific Corporation
Union Terminal Railway (of Saint Joseph, Missouri)	1	Missouri Pacific RR Company
Upper Merion & Plymouth	2	Alan Wood Steel Company
Utah	3	UV Ind., Inc.
Ware Shoals	1	Riegel Textile Corporation
Warren & Ouachita Valley	1	Chicago, Rock Island & Pacific RR Company
Warren & Saline River	1	Potlatch Corporation
Western Maryland	22	Chesapeake & Ohio; Baltimore & Ohio
Western Pacific	21	Western Pacific Ind.
Western Railway of Alabama	1	Seaboard Coast Line System
White Sulphur Springs & Yellowstone Park	1	Montana Central RR & Rec. Co., Inc.; Rockland Oil Company
Winfield	1	Penn-Dixie Ind., Inc.
Winston-Salem Southbound	2	Norfolk & Western Ry.; Seaboard
Wyandotte Terminal	1	BASF Wyandotte Corporation
Youngstown & Southern	1	Montour RR Company
Yreka Western	1	Independent

APPENDIX F

TABULATION OF RAILROAD COMPANIES BY NAME AND CODE DESIGNATIONS (ACI AND UNIFORM ALFA CODES)

This appendix lists the names of each railroad comapny which appeared in the FRA/DOT data base. The data base was compiled by Stanford Research Institute under the contract with the FRA. The work that they conducted is contained in a FRA document (#FRA-ORD-76/304) entitled, "Railroad Classification Yard Technology, A Survey and Assessment", dated January 1977. Using this data base, railroad company ACI code numbers were extracted and tehn related to the uniform alpha code and railroad company names. The results are compiled and tabulated below. The listing shown makes use of another reference document entitled, "The Official Railroad Equipment Register", Volume 93, Number 2, NRPC, New York, N.Y., dated October 1977. This document was used to correlate the code numbeer to individual railroad companies by name.

Two separate tabulations, but similar, are presented; the first listing of companies is based on ascending ACI code number, and the second listing of railroads is formated on the basis of the lexicographic order of the alpha code.

1	2	3
ASDA		ASBESTOS & DANVILLE
ASML		THE ATLANTA STONE MTN. & LITHONIA RWY. CO.
AUS		AUGUSTA & SUMMERVILLE RAILROAD CO.
AYSS		ALLEGHENY & SOUTH SIDE
BCE		BRITISH COLUMBIA HYDRO & POWER ATHORITY
BCRR		BOYNE CITY RAILROAD CO.
BMH		BEAUFORT & MOREHEAD RR CO.
CCO		CLINCHFIELD RR CO.
CPA		CLOUDERSPORT & PORT ALLEGHANY
CPLJ		CAMP LEJEUNE RAILROAD CO.
CRP		CENTRAL RR OF PENNSYLVANIA
CSP		CAMAS PRAIRIE RR CO.
CZ		COAHUILA & ZACATECAS RW.
DLC		DRUMMOND LIGHTERAGE
DW		DETROIT & WESTERN
DWML		DUE WEST MOTOR LINE
EM		EDGEMOOR & MANETTA RWY.
FCDN		FERROCARRIL DE NACOZARI, SCT.
FERR		FELICIANA EASTERN RR CO.
FLT		FOSS LAUNCH & TUG
GFC		GRAND FALLS CENTRAL RWY. CO., LTD.
GTC		GULF TRANSPORT
HDM		HUDSON & MANHATTAN
HRDL		HUDSON RIVER DAY LINE
HT		HOWARD TERMINAL
HUBA		HUDSON BAY
IGN		INTERNATIONAL-GREAT NORTHERN
ISU		IOWA SOUTHERN UTILITIES (SOUTHERN IOWA RR, INC.)
ITB		ISLAND TUG AD BARGES
JE		JERSEYVILLE & EASTERN
JGS		JAMES GRIFFITHS & SONS
JSC		JOHNSTOWN & STONY CREEK RR CO.
KCC		KANSAS CITY CONNECTING RR CO.
KCMO		KANSAS CITY, MEXICO & ORIENT
KCWB		KANSAS CITY WESTPORT BELT
KNOR		KLAMATH NORTHERN RWY. CO.
LCCE		LEE COUNTY CENTRAL ELECTRIC
LE		LOUISIANA EASTERN RR
LPSG		LIVE OAK, PERRY & S. GEORGIA RWY. CO.
MAA		MAGMA ARIZONA RR CO.
MBRR		MERIDIAN & BIGBEE RR CO.
[illegible]		[illegible] & [illegible] TRACTION CO.
MF		MIDDLE FORK
MG		THE MOBILE & GULF RR CO.
MID		MIDWAY
MLD		MIDLAND
MLST		MILSTEAD
MOT		MARINE OIL TRANSPORTATION
MTTC		MONTREAL TRAMWAYS
MVT		MT. VERNON TERMINAL
[illegible]		[illegible] NORTHWESTERN
[illegible]		[illegible]
NOTM		NEW ORLEANS, TEXAS & MEXICO
[illegible]		[illegible] R.R.
NSCT		NIAGARA, ST. CATHARINES & TORONTO

1. Uniform Alpha Code

2. ACI Code

3. Railroad Company Name

1	2	3
NYCH		NEW YORK CONNECTING RR
OMLP		OHIO MIDLAND LIGHT & POWER
PAUT		CONSOLIDATED RAIL CORP.
PBL		THE PHILADELPHIA BELT LINE RR CO.
PER		PORT EVERGLADES RWY.
PMKY		PITTSBURGH, MCKEESPORT & YOUGHIOGHENY
PPBD		PORT OF PALM BEACH DISTRICT
PSFL		PUGET SOUND FREIGHT LINES
PST		PHILADELPHIA SUBURBAN TRANSPORTATION
PSTB		PUGET SOUND TUG & BARGE
PT		PENINSULA TERMINAL CO.
PTRR		PORT TOWNSEND RR, INC.
PUCC		PORT UTILITIES
RC		ROSSLYN CONNECTING RR CO.
SBM		ST. LOUIS, BROWNSVILLE & MEXICO
SFPP		SPRUCE FALL POWER & PAPER
SIRC		THE STATEN ISLAND RR CORP.
SLS		SEA-LAND SERVICE, INC.
SNOL		SIOUX CITY & NEW ORLEANS BARGE LINE
SNCO		SEAPORT NAVIGATION
SSL		SKANEATELES SHORT LINE RR CORP.
ST		SPRINGFIELD TERMINAL RWY. CO. (VERMONT)
TASR		TANGIPAHOA & EASTERN
TAS		TAMPA SOUTHERN RR
TNO		TEMISKAMING & NORTHERN ONTARIO
TTR		TIJUANA & TECATE RWY. CO.
UCR		UTAH COAL ROUTE
UO		UNION RR OF OREGON
VS		VALLEY AND SILETZ RR CO.
WAS		WAYNESBURG SOUTHERN
WATR		WATERVILLE
WAW		CONSOLIDATED RAIL CORP.
WBC		WILKES BARRE CONNECTING RR
WIF		WEST INDIA FRUIT & STEAMSHIP
WLE		WHEELING & LAKE ERIE
WT		[illegible] TRANSPORTATION LTD.
WTCO		WESTERN TRANSPORTATION CO.
[illegible]		WASHINGTON WESTERN
AY	001	ABILENE & SOUTHERN RAILWAY CO.
ABB	002	THE AKRON & BARBERTON BELT RAILROAD COMPANY
ACY	003	THE AKRON, CANTON & YOUNGSTOWN RR CO.
AWW	004	ALGERS, WINSLOW & WESTERN RAILWAY CO.
ARR	005	THE ALASKA RAILROAD
ACBL	007	AMERICAN COMMERCIAL BARGE LINES, INC.
AC	008	ALGOMA CENTRAL RAILWAY
AR	009	ABERDEEN & ROCKFISH RAILROAD CO.
AA	010	ANN ARBOR
APA	011	THE APACHE RAILWAY COMPANY
AN	012	APALACHICOLA NORTHERN RR CO.
ARA	013	ARCADE AND ATTICA RAILROAD CORP.
ABL	014	ALAMEDA BELT LINE
ALM	016	ARKANSAS & LOUISIANA MISSOURI RWY. CO.
[illegible]	017	ALASKA [illegible] TRANSPORTATION COMPANY
ALQS	018	ALIQUIPPA & SOUTHERN RAILROAD CO.
AMC	019	AMADOR CENTRAL RAILROAD CO.
AMR	020	THE ARCATA AND MAD RIVER RAIL ROAD CO.
ADN	021	ASHLEY, DREW & NORTHERN RAILWAY CO.

1. Uniform Alpha Code

2. ACI Code

3. Railroad Company Name

1	2	3
ATSF	022	THE ATCHISON, TOPEKA & SANTA FE RWY. CO.
AWP	023	ATLANTA & WEST POINT RAILROAD CO.
ATW	025	ATLANTIC & WESTERN RAILWAY CO.
PRSL	027	CONSOLIDATED RAIL CORP.
AGS	029	THE ALABAMA GREAT SOUTHERN RAILROAD CO.
AEC	031	ATLANTIC & EAST CAROLINA RAILWAY CO.
ALS	032	THE ALTON & SOUTHERN RAILWAY CO.
AHW	033	THE AHNAPEE & WEST. RWY. CO. DIV. OF MCCLOUD RIV. RR CO.
ANR	035	ANGELINA & NECHES RIVER RR CO.
ARW	036	THE ARKANSAS WESTERN RAILWAY CO.
AVL	038	AROOSTOOK VALLEEY RALROAD CO.
AHT	039	ALASKA HYDRO-TRAIN
ASAB	042	ATLANTA & SAINT ANDREWS BAY RAILWAY CO.
APD	043	ALBANY PORT DISTRICT
AUG	044	AUGUSTA RAILROAD CO.
AL	046	ALMANOR RAILROAD CO.
ATCO	048	U.S. ENERGY RESEARCH & DEV. ADMINISTRATON
ARC	049	ALEXANDEER RALROAD COMPANY
BO	050	THE BALTIMORE & OHIO RR CO.
ART	051	AMERICAN REFRIGERATOR TRANSIT CO.
BE	052	CONSOLIDATED RAIL CORP.
BLA	053	THE BALTIMORE & ANNAPOLIS RR CO.
BFC	054	BELLEFONTE CENTRAL RR CO.
BVS	055	BEVIER & SOUTHERN RR CO.
BAR	056	BANGOR AND AROOSTOOK RAILROAD CO.
BCK	059	CONSOLIDATED RAIL CORPORATON
BEEM	060	BEECH MOUNTAIN RAILROAD CO.
BLE	061	BESSEMER & LAKE ERIE RR CO.
BLKM	063	BLACK MESA & LAKE POWELL
BOCT	064	THE BALTIMORE & OHIO CHICAGO TERM. RR CO.
BS	065	BIRMINGTON SOUTHERN RR CO.
BRW	066	BLACK RIVER & WESTERN CORP.
BM	069	BOSTON & MAINE CORP.
BME	073	BEAVER, MEADE & ENGLEWOOD
BMS	073	BERLIN MILLS
BN	076	BURLINGTON NORTHERN CO.
BAP	078	BUTTE, ANACONDA & PACIFIC RAILWAY CO.
BH	079	BATH & HAMMONDSPORT RR CO.
BRC	083	THE BELT RAILWAY CO. OF CHICAGO
BXN	084	BAUXITE & NORTHERN RAILWAY CO.
BML	087	BELFAST & MOOSEHEAD LAKE RR CO.
BRFD	088	BRANFORD STEAM RAILROAD
CSSL	090	CANADA STEAMSHIP LINES
BEDT	091	BROOKLYN EASTERN DISTRICT TERMINAL
CAD	092	CADIZ RR CO.
CLK	093	CADILLAC & LAKE CITY RWY. CO.
CWC	095	SEABOARD COAST LINE RR (CHARLESTON & WEST. CAROLINA)
CTN	097	CANTON RAILROAD CO.
CF	099	CAPE FEAR RAILWAYS, INC.
CWR	100	CALIFORNIA WESTERN RR
CI	101	CAMBRIA & INDIANA RR CO.
CN	103	CANADIAN NATIONAL RAILWAYS
CBC	104	CARBON COUNTY RWY. CO.
CP	105	CP RAIL (CANADIAN PACIFIC LTD.)
CRN	106	CAROLINA & NORTHWESTERN RWY. CO.
CKSO	107	CONDON, KINZUA & SOUTHERN RR CO.
CIC	111	CEDAR RAPIDS & IOWA CITY RAILWAY CO.

1. Uniform Alpha Code
2. ACI Code
3. Railroad Company Name

1	2	3
CCT	112	CENTRAL CALIFORNIA TRACTION CO.
CARR	113	THE CARROLLTON RR.
CACV	114	COOPERSTOWN & CHARLOTTE VALLEY RR CORP.
CGT	115	THE CANADA & GULF TERMINAL RAILWAY CO.
CIND	116	CONSOLIDATED RAIL CORP.
CHR	117	CHESTNUT RIDGE RAILWAY CO.
CGA	118	CENTRAL OF GEORGIA RAILROAD CO.
CNJ	119	CONSOLIDATED RAIL CORP.
CV	120	CENTRAL VEERMONT RWY. CO.
CHV	124	CHATTAHOOCHEE VALLEY RWY. CO.
CO	125	THE CHESAPEAKE & OHIO RWY. CO.
LM	127	LITCHFIELD & MADISON (CHIC. & N.W. TRANSP. CO.)
CEI	129	MISSOURI PACIFIC RR CO.
CIM	130	CHICAGO & ILLINOIS MIDLAND RWY. CO.
CNW	131	CHICAGO & NORTH WESTERN TRANSP. CO.
CWI	132	CHICAGO & WESTEN INDIANA RR CO.
CIL	137	LOUISVILLE & NASHVILLE RR CO. (CHIC, INDIAN. & LOUIS.)
CHTT	139	CHICAGO HEIGHTS TERMINAL TRANSFER RR CO.
MILW	140	CHICAGO, MILWAUKEE, ST. PAUL & PACIFIC RR CO.
CPLT	141	CAMINO, PLACERVILLE & LAKE TAHOE RR CO.
CHH	142	CHESWICK & HARMAR
CRI	143	CONSOLIDATED RAIL CORP.
RI	145	CHICAGO, ROCK ISLAND & PACIFIC RR CO.
CSL	147	CHICAGO SHORT LINE RWY. CO.
CPTC	149	CHICAGO PRODUCE TERMINAL CO.
CIW	150	CHICAGO & ILLINOIS WESTERN RR
CNYK	151	CENTRAL NEW YORK RR CORP.
CNTP	153	THE CINCINNATI, NEW ORLEANS & TEXAS PACIFIC RWY. CO.
CS	157	THE COLORADO & SOUTHERN RWY. CO.
CW	158	THE COLORADO & WYOMING RWY. CO.
CNL	159	COLUMBIA, NEWBERRY & LAURENS RR CO.
CLC	163	COLUMBIA & COWITZ RWY. CO.
COLI	164	COLONEL'S ISLAND
COP	166	CITY OF PRINEVILLE RWY.
CNOR	167	CINCINNATI NORTHERN
CSS	168	CHICAGO SOUTH SHORE & SOUTH BEND RR
CLP	169	THEE CLARENDON & PITTSFORD RR CO.
CWP	172	CHICAGO, WEST PULLMAN & SOUTHERN RR CO.
CAGY	177	COLUMBUS & GREENVILLE RWY. CO., INC.
CHW	179	CHESAPEAKE WESTERN RAILWAY
CMER	180	CURTIS, MILBURN & EASTERN RR CO.
CLIF	181	CLIFFSIDE RR CO.
CORB	184	CURTIS BAY RR CO.
CIRC	185	CENTRAL IOWA TRANSP. COOP. DBA CENT. IOWA RWY. CO.
CUVA	186	THE CUYAHOGA VALLEEY RWY. CO.
CLCO	188	CLAREMONT & CONCORD RWY. CO., INC.
CRE	189	CONSOLIDATED RAIL CORP. (EASTERN DISTRICT)
CR	190	CONSOLIDATED RAIL CORP.
DR	191	DARDANELLE & RUSSELLVILLE RR CO.
DRI	192	DAVEENPORT, ROCK ISLAND & NORTHWESTERN RWY. CO.
DVS	193	DELTA VALLEY & SOUTHERN RWY. CO.
DH	195	DELAWARE & HUDSON RAILWAY CO.
DC	196	DELRAY CONNECTING RAILROAD COMPANY
DRGW	197	THE DENVER & RIO GRANDE WESTEN RR CO.
DQE	200	DE QUEEN & EASTERN RR CO.
CCR	201	THE CORINTH & COUNCE RR CO.
DMU	202	DES MOINES UNION RWY. CO.
DM	204	DETROIT & MACKINAC RWY. CO.

1. Uniform Alpha Code

2. ACI Code

3. Railroad Company Name

1	2	3
DTS	205	THE DETROIT AND TOLEDO SHORE LINE RR CO.
BRR	207	BELTON RR CO.
DTI	208	DETROIT, TOLEDO & IRONTON RR CO.
DA	209	CP RAIL (CANADIAN PAC. LTD.) (DOM. ATL. RWY. CO.)
DKS	210	DONIPHAN, KENSETT & SEARCY RWY.
DNE	212	DULUTH & NORTHEASTERN RR CO.
DMIR	213	DULUTH, MISSABE & IRON RANGE RWY. CO.
CBL	215	CONEMAUGH & BLACK LICK RR CO.
DWP	216	DULUTH, WINNIPEG & PACIFIC RWY.
DS	217	DURHAM & SOUTHERN RWY. CO.
DT	219	DETROIT TERMINAL RR CO.
DMM	220	THE DANSVILLE AND MOUNT MORRIS RR CO.
CIRR	222	CHATTAHOOCHEE INDUSTRIAL RR
ETL	228	THE ESSEX TERMINAL RWY. CO.
EEC	229	EAST ERIE COMMERCIAL RR
EV	231	THE EVERETT RR CO.
ETWN	234	EAST TENNESSEE & WESTERN N.C. RR CO.
EJE	238	ELGIN, JOLIET & EASTERN RWY. CO. (CHIC. & OUTER BELT)
EL ✓	240	CONSOLIDATED RAIL CORP.
ELS	241	ESCANABA & LAKE SUPERIOR RR CO.
EACH	242	EAST CAMDEN & HIGHLAND RR. CO.
EJR	245	EAST JERSEY RR AND TERMINAL CO.
EN	246	ESQUIMALT & NANAIMO RWY. CO.
EDW	247	EL DORADO & WESSON RWY. CO.
FPE	260	FAIRPORT, PAINSVILLE & EASTERN RWY. CO.
FEC	263	FLORIDA EAST COAST RWY. CO.
FJG	264	FONDA, JOHNSTOWN & GLOVERSVILLE RR CO.
FP	265	FORDYCE & PRINCETON RR CO.
FDDM	266	CHICAGO & NW TRANSP. CO. (FT. DODGE, DES MOINES & SOUTH RWY.)
FWD	268	FT. WORTH & DENVER RWY. CO.
FCIN	272	FRANKFORT & CINCINNATI RR CO.
FRDN	273	FERDINAND RR CO.
FWU	274	FT. WAYNE UNION
FCM	275	FERROCARRIL MEXICANO (MEXICAN)
FMS	276	FORT MYERS SOUTHERN RR CO.
FWB	277	FT. WORTH BELT RWY. CO.
FSVB	279	FT. SMITH & VAN BUREN RWY. CO.
SEE	281	FERROCARRILES UNIDOS DEL SURESTE, S.A. DE C.V.
FOR	282	FORE RIVER RR CORP.
SBC	283	FERROCARRIL SONORA BAJA CALIF., S.A. DE C.V.
MDP	285	MEXICANN PACIFIC RR CO.,INC. (FERROCARRIL MEX.DEL PACIFICO)
NDM	286	FERROCARRILES NACIONALES DE MEX (NATL.RWYS.OF MEX.) (CARS MKD.NDEM)
GCW	287	THE GARDEN CITY WESTERN RWY. CO.
GC	289	GRAHAM CTY. RR CO.
GM	290	GAINSVILLE MIDLAND RR CO.
NDT	291	FERROCARRIL NACIONAL DE TEHUANTEPEC (TEHUANTEPEC NAT'L.)
MGRS	292	FERROCARRILES NACIONALES DE MEXICO (NAT'L. RWYS OF MEXICO)
GHH	293	GALVESTON, HOUSTON & HENDESON RR CO.
GETY	294	GETTYSBURG RR CO.
GANO	298	THE GEORGIA NORTHERN RWY. CO.
GA	299	GEORGIA RR CO.
GSF	300	GEORGIA SOUTHERN & FLORIDA RWY. CO.
GRR	302	GEORGETOWN RR CO.
GWF	303	GALVESTON WHARVES
GSW	305	GREAT SOUTHWEST R.R., INC.
GRN	306	GREENVILLE & NORTHERN RWY. CO.
GNA	307	GRAYSONIA, NASHVILLE & ASHDOWN RR CO.

1. Uniform Alpha Code

2. ACI Code

3. Railroad Company Name

1	2	3
GTW	308	GRAND TRUNK WESTERN RR CO.
GWR	311	THE GREAT WESTERN RWY. CO.
GBW	312	GREEN BAY & WESTERN RR CO.
GMRC	314	GREEN MTN. RR CORP.
GMO	317	ILLINOIS CENTRAL GULF RR CO. (GULF, MOBLE & OHIO RR CO.)
GWIN	319	GOODWIN RR INC.
GNWR	320	GENESEE & WYOMING RR CO.
GJ	321	GREENWICH & JOHNSONVILLE RWY. CO.
GRNR	322	THE GRAND RIVER RWY. CO.
GU	323	GRAFTON & UPTON RR CO.
HCRC	326	HILLSDALE CTY. RWY. CO., INC.
HE	328	HOLLIS & EASTERN RR CO.
HBS	329	HOBOKEN SHORE RR
HB	330	HAMPTON & BRANCHVILLE RR CO.
HSW	331	HELENA SOUTHWESTERN RR CO.
HN	332	THE HUTCHINSON & NORTHERN RWY. CO.
HRT	334	HARTWELL RWY. CO.
HMR	335	HOBOKEN MANUFACTURERS
HS	336	HARTFORD & SLOCOMB RR CO.
HLNE	338	HILLSBORO & NORTH EASTERN RWY. CO.
HI	339	HOLTON INTER-URBAN RWY. CO.
HBT	342	HOUSTON BELT & TERMINAL RWY. CO.
ICG	350	ILLINOIS CENTRAL GULF RR CO.
IC	351	ILLINOIS CENTRAL GULF RR CO. (ILLINOIS CENTRAL)
IU	353	INDIANAPOLIS UNION
ITC	354	ILLINOIS TERMINAL RR CO.
NCAN	356	INCAN SUPERIOR LTD.
IHB	357	INDIANA HARBOR BELT RR CO.
IBT	358	THE INTENATONAL BRIDGE & TERMINAL CO.
INT	361	INTESTATE RR CO.
DCI	362	DES MOINES & CENTRAL IOWA RAILWAY CO.
IRN	364	CONSOLIDATEED RAIL CORP.
HPTD	366	HIGH POINT, THOMASVILLE & DENTON RR CO.
SIRR	367	SOUTHERN INDUSTRIAL RR INC.
LAL	398	LIVONIA, AVON & LAKEVILLE RR CORP.
KCS	400	THE KANSAS CITY SOUTHERN RW. CO.
KCT	401	KANSAS CITY TERMINAL RWY. CO.
KIT	402	KEENTUCKY & INDIANA TERMINAL RR CO.
KENN	403	KENNECOTT COMPANY RR
LT	404	THE LAKE TERMINAL RR CO.
KT	405	KEENTUCKY & TENNESSEE RWY.
LEE	406	THE LAKE ERIE & EASTERN RR CO.
LDRT	407	THE LAKE FRONT DOCK & RR TERMINAL CO.
LASB	409	LACKAWAXEN & STOURBRIDGE RR CORP.
KC	410	THE KANAWHA CENTRAL RWY. CO.
KCNW	411	KELLEY'S CREEK & NORTHWESTERN RR CO.
KNC	412	KINGCOME NAVIGATION
LNE	413	CONSOLIDATED RAIL CORP.
KM	414	THE KANSAS & MISSOURI RWY. & TERMINAL CO.
LSTT	417	LAKE SUPERIOR TEMINAL & TRANSFER RWY. CO.
LWV	419	CONSOLIDATED RAIL CORP.
LEN	421	THE LAKE ERIE & NORTHERN RWY. CO.
LSBC	420	THE LA SALLE & BUREAU CTY. RR CO.
LTC	422	LAFFERTY TRANSPORTATION
LEF	423	LAKE ERIE, FRANKLIN & CLARION RR CO.
LEFW	424	LAKE ERIE & FT. WAYNE RR CO.

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3. Railroad Company Name

1	2	3
LSI	425	LAKE SUPERIOR & ISHPEMING RR CO.
LC	426	LANCASTER & CHESTER RWY. CO.
LRS	427	LAURINBURG & SOUTHERN RR CO.
LAJ	428	LOS ANGELES JUNCTION RWY. CO.
LHR	429	CONSOLIDATED RAIL CORP.
LON	430	LUDINGTON & NORTHERN RWY.
LV	431	CONSOLIDATED RAIL CORP.
LNO	434	LAONA & NORTHERN RWY. CO.
LRPA	435	LITTLE ROCK PORT RR
LI	436	THE LONG ISLAND RR CO.
LAWV	437	THE LORAIN & WEST VIRGINIA RWY. CO.
LDTC	439	LAWNDALE TRANSPORTATON CO.
LA	441	LOUISIANA & ARKANSAS RWY. CO.
LNW	442	THE LOUISIANA & NORTHWEST RR CO.
LPB	443	THE LOUISIANA & PINE BLUFF RWY. CO.
LN	444	LOUISVILLE & NASHVILLE RR CO.
LSO	445	LOUISIANA SOUTHERN RWY. CO.
LNAC	446	LOUISVILLE, NEW ALBANY & CORYDON RR CO.
LBR	447	THE LOWVILLE & BEAVER RIVER RR CO.
LCAM	448	LOUISIANA MIDLAND RWY. CO.
NC	449	LOUISVILLE & NASHVILLE RR CO. (NASHVLE, CHATANOOGA & ST. LOUIS)
LPN	450	LONGVIEW, PORTLAND & NORTHERN RWY. CO.
LW	451	LOUISVILLE & WADLEY RWY. CO.
MDRY	455	MADISON RWY. CO., INC.
MEC	456	MAINE CENTRAL RR CO.
BNML	457	BURLINGTON NORTHERN (MANITOBA) LIMITED
MJ	459	MANUFACTURERS' JUNCTION RWY. CO.
MRS	460	MANUFACTURERS RWY. CO.
MCER	461	MASSACHUSEETTS CENTRAL
MPA	463	MARYLAND & PENNSYLVANIA RR CO.
MWR	464	MUNCIE & WESTERN RR CO.
MD	465	MUNICIPAL DOCKS
MCR	466	MC CLOUD RIVER RR CO.
MTC	467	MYSTIC TERMINAL CO.
MBT	468	MARIANNA & BLOUNTSTOWN RR CO.
MAYW	469	MAYWOOD & SUGAR CREEK
CHP	470	FERROCARRIL CHIHUAHUA AL PACIFICO, S.A.
MSTR	471	THE MASSENA TERMINAL RR CO.
MC	472	CONSOLIDATED RAIL CORP.
FLMA	473	FERROCARRIL DE MINATITAN AL CARMEN
MINE	474	MINNEAPOLIS EASTERN RWY. CO.
MNJ	475	MIDDLETOWN & NEW JERSEY RWY. CO., INC.
MIDH	479	MIDDLETOWN & HUMMELSTOWN RR CO.
MNS	480	MINNEAPOLIS, NORTHFIELD & SOUTHERN RWY.
SOO	482	SOO LINE RR CO.
MTFR	484	THE MINNESOTA TRANSFER RWY. CO.
MSLC	486	MINNESOTA SHORT LINES CO.
LMT	488	LOUISIANA MIDLAND TRANSPORT
MKT	490	MISSOURI-KANSAS-TEXAS RR CO.
MP	494	MISSOURI PACIFIC RR CO.
MGA	497	THE MONONGAHELA RWY. CO.
MCRR	498	THE MONONGAHELA CONNECTING RR CO.
MIGN	501	MICHIGAN NORTHERN RWY. CO., INC.
MTR	500	MONTOUR RR CO.
MISS	502	MISSISSIPPIAN
MSV	503	MISSISSIPPI & SKUNA VALLEY RR CO.
MSE	506	MISSISSIPPI EXPORT RR CO.

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3. Railroad Company Name

1	2	3
MOV	507	MOSHASSUCK VALLEY RR CO.
FBL	508	FEDERAL BARGE LINES
MB	509	MONTPELIER & BARRE RR CO.
MDW	510	MINNESOTA, DAKOTA & WESTERN RWY. CO.
ME	511	MORRISTOWN & ERIE RR CO.
IAT	513	IOWA TEMINAL RR CO.
MI	515	MISSOURI-ILLINOIS RR CO.
MTW	520	MARINETTE, TOMAHAWK & WESTERN RR
MIR	522	MINNEAPOLIS INDUSTRIAL RWY. CO.
METW	523	MUNICIPALITY OF EAST TROY, WISCONSIN
NAP	525	THE NARRAGANSETT PIER RR CO., INC.
NN	530	NEVADA NORTHERN RWY. CO.
NJII	533	N.J., INDIANA & ILLINOIS RR CO.
NLC	534	NEW ORLEANS & LOWER COAST RR CO.
NOPB	536	NEW ORLEANS PUBLIC BELT RR
NEZP	537	NEZPERCE RR CO.
NIAJ	538	CONSOLIDATED RAIL CORP.
NYLB	539	CONSOLIDATED RAIL CORP.
NYD	542	NEW YORK DOCK RWY.
NYSW	546	N.Y.,SUSQUEHANNA & WEST. RR CO. (WALTER G. SCOTT,TRUSTEE)
MCSA	548	MOSCOW, CAMDEN & SAN AUGUSTINE RR
NPB	549	NORFOLK & PORTSMOUTH BELT LINE RR CO.
NW	550	NORFOLK & WESTERN RWY. CO. (N & W DIST.)
NS	551	NORFOLK SOUTHERN RWY. CO.
MH	552	MOUNT HOOD RWY. CO.
NLG	553	NORTH LOUISIANA & GULF RR CO.
NB	554	NORTHAMPTON AND BATH RR CO.
NWP	559	NORTHWESTERN PACIFIC RR CO.
NJ	562	NAPIERVILLE JUNCTION RWY. CO.
NAR	563	NORTHERN ALBERTA RAILWAYS CO.
NBST	567	THE NEW BRAUNFELS & SERVTEX RR CO.
NSRC	570	NORTH STRATFORD RR CORP.
NSS	577	THE NEWBURGH & SOUTH SHORE RWY. CO.
SOR	578	SUN OIL CO. OF PENNA.
AD	580	NORFOLK, FRANKLIN & DANVILLE RAILWAY CO.
MHM	581	CONSOLIDATED RAIL CORP.
NFD	582	NORFOLK, FRANKLIN & DANVILLE RWY. CO.
MKC	583	MCKEESPORT CONNECTING RR CO.
MHCO	584	MARQUETTE & HURON MTN. RR CO., INC.
NHIR	585	NEW HOPE & IVYLAND RR CO.
OTR	586	TE OAKLAND TERMINAL RWY.
OCTR	587	OCTORARO RWY. INC.
NOKL	591	NORTHWESTERN OKLAHOMA RR CO.
ONRY	592	OGDENSBURG BRIDGE & PORT AUTHORITY
PFE	595	PACIFIC FRUIT EXPRESS CO.
ONW	596	OREGON & NORTHWESTERN RR CO.
OPE	597	OREGON, PACIFIC & EASTERN RWY. CO.
OLB	598	OMAHA, LINCOLN & BEATRICE RWY. CO.
OE	600	OREGON ELECTRIC RWY. CO.
OT	601	OREGON TRUNK RAILWAY
OCE	603	OREGON, CALIF., & EASTERN RWY. CO.
OR	604	OWASCO RIVER
PRT	606	PARR TERMINAL RR
PAM	607	PITTSBURGH, ALLEGHENY & MCKEES ROCKS RR CO.
PBR	609	PATAPSCO & BACK RIVERS RR CO.
PM	610	THE CHESAPEAKE & OHIO RWY. CO. (PERE MARQUETTE DIST.)
PI	614	PADUCAH & ILLINOIS RR

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1	2	3
PAE	615	CONSOLIDATED RAIL CORP.
POV	616	PITTSBURGH & OHIO VALLEY RWY. CO.
PTM	619	PORTLAND TERMINAL CO. (ME.)
PC ✓	622	CONSOLIDATED RAIL CORP.
RDG ✓	623	CONSOLIDATED RAIL CORP.
PICK	624	THE PICKENS RR CO.
PLE	626	THE PITTSBURGH & LAKE ERIE RR CO.
PS	627	THE PITTSBURGH & SHAWMUT RR CO.
PCY	629	PITTSBURGH, CHARTIERS & YOUGHIOGHENY RWY. CO.
PF	630	THE PIONEER & FAYETTE RAILROAD CO.
PW	631	PROVIDENCE & WORCESTER CO.
PRTD	632	PORTLAND TRACTION CO. (PORTLAND RR & TERMINAL DIV.)
PNW	634	THE PRESCOTT & NORTHWESTERN RR CO.
PRV	636	PEARL RIVER VALLEY RR CO.
PSR	639	PETALUMA & SANTA ROSA RR CO.
PNS	640	PHILADELPHIA & NORFOLK STEAMSHIP
PVS	644	THE PECOS VALLEY SOUTHERN RWY. CO.
PPU	645	PEORIA & PEKIN UNION RWY. CO.
PTC	646	PEORIA TERMINAL CO.
PHD	647	PORT HURON AD DETROIT RR CO.
PJR	648	PORT JERSEY
BFCF	650	BREMERTON FREIGHT CAR FERRY
PCN	651	POINT COMFORT & NORTHERN RWY. CO.
QAP	655	QUANAH, ACME & PACIFIC RW. CO.
QRR	656	QUINCY RR CO.
QC	658	QUEBIC CENTRAL RAILWAY CO.
PBNE	659	PHILA., BETHLEHEM & NEW ENGLAND RR CO.
RSB	662	ROCHESTER SUBWAY
RFP	663	RICHMOND, FREDERICKSBURG & POTOMAC RR CO.
RV	664	RAHWAY VALLEY R.R. RAHWAY VALLEY CO., LESSER
RT	665	THE RIVER TERMINAL RAILWAY CO.
RTM	666	THE RAILWAY TRANSFER CO. OF TE CITY OF MINNEAPOLIS
RS	669	THE ROBERVAL AND SAGUENAY RWY. CO.
RR	671	RARITAN RIVER RAIL ROAD CO.
RSP	673	ROSCOE, SNYDER & PACIFIC RWY. CO.
RSS	675	[illegible]DALE, SANDOW & SOUTHERN RR CO.
RCR	676	ROCKTON & RON RWY.
PBVR	677	THE PORT BIENVILLE RR
SRN	678	SABINE RIVER & NORTHERN RR CO.
SSDK	679	SAVANNAH STATE DOCKS RR CO.
SJB	680	ST. JOSEPH BELL RWY. CO.
SC	681	SUMTER & CHOCTAW RWY. CO.
SM	682	ST.MARY'S RR CO.
SJT	683	ST. JOSEPH TERMINAL RR CO.
SJRT	685	ST. JOHNS RIVER TERMINAL
SRC	686	STRASBURG RR CO.
SCM	687	STROUDS CREEK & MUDDLETY RR
SLGW	690	SALT LAKE, GARFIELD & WESTERN RWY. CO.
SAN	691	SANDERSVILLE RR CO.
SLSF	693	ST. LOUIS-SAN FRANCISCO RWY. CO.
SSW	694	ST. LOUIS SOUTHWESTERN RWY. CO.
SLC	696	THE SAN LUIS CENTRAL RR CO.
SN	697	SACRAMENTO NORTHERN RWY.
SDAE	702	SAN DIEGO & ARIZONA EASTERN RWY. CO.
SSH	704	SOUTH SHORE
SLAW	705	ST. LAWRENCE RR, DIV. OF NAT'L. RWY. UTILIZATON CORP.
SSLV	706	SOUTHERN SAN LUIS VALLEY RR CO.
SS	707	SAND SPRINGS RWY. CO.
TSU	709	TULSA-SAPULPA UNION RWY. CO.

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1	2	3
DVR	711	CAPE BRETON DEV. CORP. (COAL DIV.) DEVCO RWY.
SCL	712	SEABOARD COAST LINE RR CO.
STL	714	SEATRAIN LINES, INC.
SERA	716	SIERRA RAILROAD CO.
SBK	718	SOUTH BROOKLYN RWY. CO.
SIND	720	SOUTHERN INDIANA RWY., INC.
SP	721	SOUTHERN PACIFIC TRANSPORTATION CO.
SOU	724	SOUTHERN RWY. SYSTEM
SI	727	SPOKANE INTERNATIONAL RR CO.
STRT	729	THE STEWARTSTOWN RR CO.
SUN	734	SUNSET RAILWAY CO.
SCT	735	SIOUX CITY TERMINAL RWY.
SOPR	736	SOUTH PIERCE RR
FCP	738	FERROCARRIL DEL PACIFICO, S.A. DE C.V. (PAC FC DEL P)
STE	739	STOCKTON TERMINAL & EASTERN RR
SMV	741	SANTA MARIA VALLEY RR CO.
TEXC	750	TEXAS CENTRAL RR CO.
ONT	754	ONTARIO NORTHLAND RWY.
TAG	755	TENNESSEE, ALABAMA & GA. RWY. CO.
TRRA	757	TERMINAL RR ASSOC. OF ST. LOUIS
TASD	758	TERMINAL RWY., ALABAMA STATE DOCKS
TMBL	759	TACOMA MUNICIPAL BELT LINE RWY.
TP	760	MISSOURI PACIFIC RR CO.
TCT	761	TEXAS CITY TERMINAL RWY. CO.
TM	762	THE TEXAS MEXICAN RWY. CO.
TPMP	763	TEXAS PACIFIC-MISSOURI PACIFIC TERMINAL RR OF N. ORLEAS
TOE	764	TEXAS, OKLAHOMA & EASTERN RR CO.
TSE	765	TEXAS SOUTH EASTERN RR CO.
TENN	767	TENNESSEE RAILWAY CO.
TPW	769	TOLEDO, PEORIA & WESTERN RR CO.
TT	771	THE TOLEDO TERMINAL RR CO.
THB	774	THE TORONTO, HAMILTON & BUFFALO RWY. CO.
TPT	778	CONSIIDATED RAIL CORP.
TRC	779	TRONA RWY. CO.
TOV	782	TOOELE VALLEY RWY. CO.
TCG	783	TUSCON, CORNELIA & GILA BEND RR CO.
TS	784	TIDEWATER SOUTHERN RWY. CO.
TAW	785	THE TOLEDO, ANGOLA & WESTERN RWY. CO.
TNM	788	TEXAS-NEW MEXICO RWY. CO.
SB	791	SOUTH BUFFALO RAILWAY CO.
SOT	792	SOUTH OMAHA TERMINAL RWY. CO.
SJL	793	ST. JOHNSBURY & LAMOILLE CTY. RR.
SMA	794	SAN MANUEL ARIZONA RR CO.
TN	795	TEXAS & NORTHERN RWY. CO.
TYC	796	TYLERDALE CONNECTING
WRWK	797	WARWICK RWY. CO.
TB	798	TWIN BRANCH RR CO.
SH	799	STEELTON & HIGHSPIRE RR CO.
UP	802	UNION PAC. RR CO.(OREGON SHORT LINE:ORE.-WASH RR & NAVIGAT.)
URR	803	UNION RR CO. (PITTSBURGH, PA.)
URY	804	UNION RY. OF MEMPHIS
UNI	805	UNITY RWYS. CO.
UT	807	UNION TERMINAL RWY. (OF ST. JOSEPH, MO.)
UMP	808	UPPER MERION & PLYMOUTH RR CO.
UTR	809	UNION TRANSPORTATION
UTAH	811	UTAH RWY. CO.
VALE	814	THE VALLEY RR CO.

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3. Railroad Company Name

1	2	3
VAMD	815	VIRGINIA & MARYLAND RR
VSO	816	VALDOSTA SOUTHERN RR
VTR	817	VERMONT RWY. INC.
VBR	819	VIRGINIA BLUE RIDGE RWY.
VC	820	VIRGINIA CENTRAL RWY.
VCY	821	VENTURA CTY. RWY. CO.
VNOR	822	VERMONT NORTHERN RR CO.
VE	824	VISALIA ELECTRIC RR CO.
WWV	826	WALLA WALLA VALLEY RWY. CO.
WAR	827	WARRENTON RR CO.
WS	828	WARE SHOALS RR C.
WQV	829	WARREN & QUACHITA VALLEY RWY. CO.
WYS	830	WYANDOTTE SOUTHEERN RR C.
WIM	831	WASHINGTON, IDAHO & MONTANA RWY. CO.
WSR	832	WARREN & SALINE RIVER RR CO.
WYT	833	WYANDOTTE TERMINAL RR CO.
WAL	834	WESTERN ALLEGHENY RR CO.
WLO	835	WATERLOO RR CO.
WMWN	837	THE WEATHERFORD, MINEAL WELLS & NORTHWESTEN RWY. CO.
WRRC	838	WESTERN RAIL ROAD CO.
WM	839	WESTERN MARYLAND RWY. CO.
WP	840	THE WESTERN PACIFIC RR CO.
WA	841	THE WESTERN RWY. OF ALABAMA
WHN	842	CONSOLIDATED RAIL CORP.
WCTR	844	WCTU RWY. CO.
WPY	845	WHITE PASS & YUKON ROUTE
WSYP	846	WHITE SULPHUR SPRINGS & YELLOWSTONE RWY. CO.
WMSC	847	WHITE MOUNTAIN SCENIC RR
WAG	848	WELLSVILLE, ADDISON & GALETON RR CORP.
WATC	849	THE WASHINGTON TERMINAL CO.
WW	850	WINCHESTER & WESTERN RR CO.
WNF	851	THE WINFIELD RR CO.
WNFR	852	WINFREDE RR CO.
WSS	854	WINSTON-SALEM SOUTHBOUND RWY. CO.
WTOH	865	WESTERN OHIO RR CO.
WVN	866	WEST VIRGINIA NORTHERN RR C.
WBTS	867	WACO, BEAUMONT, TRNITY & SABINE RWY CO.
WLFB	869	WOLFEBORO RR CO., INC.
YVT	872	YAKIMA VALLEY TRANSPORTATION CO.
YW	873	YREKA WESTERN RR CO.
YS	875	YOUNGSTOWN & SOUTHERN RWY. CO.
YAN	876	YANCEY RR C.
YN	877	THE YOUNGSTOWN & NORTHERN RR CO.
BTCO	950	BOSTON TERMINAL CO.
CUST	951	CHICAGO UNION STATION CO.
FSUD	952	FORT STREET UNION DEPOT CO.
JTCO	953	JACKSONVILLE TERMINAL CO.
LAPT	954	LOS ANGELES UNION PASSENGER TERMINAL
MTCO	955	MACON TERMINAL CO.
OURD	956	THE OGDEN UNION RWY. & DEPOT CO.
SPUD	957	ST. PAUL UNION DEPOT CO.
TUST	958	TEXARKANA UNION STATION TRUST
DUTC	959	DALLAS UNION TERMINAL
NOT	960	NEW ORLEANS TERMINAL
MUSC	961	MEMPHIS UNION STATION CO.
MWRC	962	MT. WASHINGTON RWY. CO.
NPT	964	PORTLAND TERMINAL RR CO. (ORE.)
BCOL	997	BRITISH COLA. RWY. CO.

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3. Railroad Company Name

1	2	3
AA	010	ANN ARBOR
ABB	002	THE AKRON & BARBERTON BELT RAILROAD COMPANY
ABCK	017	ALASKA BRITISH COLUMBIA TRANSPORTATION COMPANY
ABL	014	ALAMEDA BELT LINE
AC	008	ALGOMA CENTRAL RAILWAY
ACBL	007	AMERICAN COMMERCIAL BARGE LINES, INC.
ACY	003	THE AKRON, CANTON & YOUNGSTOWN RR CO.
AD	580	NORFOLK, FRANKLIN & DANVILLE RAILWAY CO.
ADN	021	ASHLEY, DREW & NORTHEEERN RAILWAY CO.
AEC	031	ATL. & EAST COAST RAILWAY CO.
AGS	029	THE ALABAMA GREAT SOUTHERN RAILROAD CO.
AHT	039	ALASKA HYDRO-TRAIN
AHW	033	THE AHNAPEE & WEST. RWY. CO. DIV. OF MCCLOUD RIV. RR CO.
AL	046	ALMANOR RAILROAD CO.
ALM	016	ARKANSAS & LOUISIANA MISSOURI RWY. CO.
ALQS	018	ALIQUIPPA & SOUTHERN RAILROAD CO.
ALS	032	THE ALTON & SOUTHERN RAILWAY CO.
AMC	019	AMADOR CENTRAL RAILROAD CO.
AMR	020	THE ARCATA AND MAD RIVER RAIL ROAD CO.
AN	012	APALACHICLA NORTHERN RR CO.
ANR	035	ANGELINA & NECHES RIVER RR CO.
APA	011	THE APACHE RAILWAY COMPANY
APD	043	ALBANY PORT DISTRICT
AR	009	ABERDEEN & ROCKFISH RAILROAD CO.
ARA	013	ARCADE AND ATTICA RALROAD CORP.
ARC	049	ALEXANDEER RALROAD COMPANY
ARR	005	THE ALASKA RAILROAD
ART	051	AMERICAN REFRIGERATOR TRANSIT CO.
ARW	036	THE ARKANSAS WESTERN RAILWAY CO.
AS	001	ABILENE & SOUTHERN RALWAY CO.
ASAB	042	ATLANTA & SANT ANDREWS BAY RAILWAY CO.
ASDA		ASBESTOS & DANVILLE
ASML		THE ATLANTA STONE MTN. & LITHONIA RWY. CO.
ATCO	048	U.S. ENERGY RESEARCH & DEV. ADMINISTRATON
ATSF	022	THE ATCHISON, TOPEKA & SANTA FE RWY. CO.
ATW	025	ATLANTIC & WESTERN RAILWAY CO.
AUG	044	AUGUSTA RAILROAD CO.
AUS		AUGUSTA & SUMMERVILLE RAILROAD CO.
AVL	038	AROOSTOOK VALLEEY RALROAD CO.
AWP	023	ATLANTA & WEST POINT RAILROAD CO.
AWW	004	ALGES, WINSLOW & WESTERN RAILWAY CO.
AYSS		ALLEGHENY & SOUTH SIDE
BAP	078	BUTTE, ANACONDA & PACIFIC RAILWAY CO.
BAR	056	BANGOR AND AROOSTOOK RAILROAD CO.
BCE		BRITISH COLUMBIA HYDRO & POWER ATHORITY
BCK	059	CONSOLIDATED RAIL CORPORATON
BCCL	997	BRITISH COLA. RWY. CO.
BCRR		BOYNE CITY RAILROAD CO.
BE	052	CONSOLIDATED RAIL CORP.
BEDT	091	BROOKLYN EASTERN DISTRICT TERMINAL
BEEM	060	BEECH MOUNTAIN RAILROAD CO.
BFC	054	BELLEFONTE CENTRAL RR CO.
BFCF	650	BREMERTON FREIGHT CAR FERRY
BH	079	BATH & HAMMONDSPORT RR CO.
BLA	053	THE BALTIMORE & ANNAPOLIS RR CO.
BLE	061	BESSEMER & LAKE ERIE RR CO.
BLKM	063	BLACK MESA & LAKE POWELL
BM	069	BOSTON & MAINE CORP.

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3. Railroad Company Name

1	2	3
BME	073	BEAVER, MEADE & ENGLEWOOD
BMH		BEAUFORT & MOOREHEAD RR CO.
BML	087	BELFAST & MOOSEHEAD LAKE RR CO.
BMS	073	BEERLIN MILLS
BN	076	BURLINGTON NORTHERN CO.
BNML	457	BURLINGTON NORTHERN (MANITOBA) LIMITED
BO	050	THEE BALTIMORE & OHIO RR CO.
BOCT	064	THE BALTIMORE & OHIO CHICAGO TERM. RR CO.
BRC	083	THE BELT RAILWAY CO. OF CHICAGO
BRFD	088	BRANFORD STEAM RAILROAD
BRR	207	BELTON RR CO.
BRW	066	BLACK RIVER & WESTERN CORP.
BS	065	BIRMINGTON SOUTHERN RR CO.
BTCO	950	BOSTON TERMINAL CO.
BVS	055	BEVIER & SOUTHERN RR CO.
BXN	084	BAUXITE & NORTHERN RAILWAY CO.
CACV	114	COOPERSTOWN & CHARLOTTE VALLEY RR CORP.
CAD	092	CADIZ RR CO.
CAGY	177	COLUMBUS & GREENVILLE RWY. CO., INC.
CARR	113	THE CARROLLTON RR.
CBC	104	CARBON COUNTY RWY. CO.
CBL	215	CONEMAUGH & BLACK LICK RR CO.
CCO		CLINCHFIELD RR CO.
CCR	201	THE CORINTH & COUNCE RR CO.
CCT	112	CENTRAL CALIFORNIA TRACTION CO.
CEI	129	MISSOURI PACIFIC RR CO.
CF	099	CAPE FEAR RAILWAYS, INC.
CGA		CENTRAL OF GEORGIA RAILROAD CO.
CGT	115	THE CANADA & GULF TERMINAL RAILWAY CO.
CHH	142	CHESWICK & HARMAR
CHP	470	FEERROCARRIL CHIHUAHUA AL PACIFICO, S.A.
CHR	117	CHESTNUT RIDGE RAILWAY CO.
CHTT	139	CHICAGO HEIGHTS TERMINAL TRANSFER RR CO.
CHV	124	CHATTAHOOCHEE VALLEY RWY. CO.
CHW	179	CHESAPEAKE WESTERN RAILWAY
CI	101	CAMBRIA & INDIANA RR CO.
CIC	111	CEDAR RAPIDS & IOWA CITY RAILWAY CO.
CIL	137	LOUISVILLE & NASHVILLE RR CO. (CHIC. INDIAN. & LOUIS.)
CIM	130	CHICAGO & ILLINOIS MIDLAND RWY. CO.
CIND	116	CONSOLIDATED RAIL CORP.
CIRC	185	CENTRAL IOWA TRANSP. COOP. DBA CENT. IOWA RWY. CO.
CIRR	222	CHATTAHOOCHEE INDUSTRIAL RR
CIW	150	CHICAGO & ILLINOIS WESTERN RR
CKSO	107	CONDON, KINZUA & SOUTHERN RR CO.
CLC	163	COLA. & COWITZ RWY. CO.
CLCO	188	CLAREMONT & CONCORD RWY. CO., INC.
CLIF	181	CLIFFSIDE RR CO.
CLK	093	CADILLAC & LAKE CITY RWY. CO.
CLP	169	THEE CLARENDON & PITTSFORD RR CO.
CMER	180	CURTIS, MILBURN & EASTERN RR CO.
CN	103	CANADIAN NATIONAL RAILWAYS
CNJ	119	CONSOLIDATED RAIL CORP.
CNL	159	COLUMBIA, NEWBERRY & LAURENS RR CO.
CNOR	167	CINCINNATI NORTHERN
CNTP	153	THE CINCINNATI, NEW ORLEANS & TEXAS PACIFIC RWY. CO.
CNW	131	CHICAGO & NORTH WESTERN TRANSP. CO.
CNYK	151	CENTRAL NEW YORK RR CORP.
CO	125	THE CHESAPEAKE & OHIO RWY. CO.

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1	2	3
CCLI	164	COLONELS ISLAND
COP	166	CITY OF PRINEVILLE RWY.
CP	105	CP RAIL (CANADIAN PACIFIC LTD.)
CPA		COUDERSPORT & PORT ALLEGHANY
CPLJ		CAMP LEJEUNE RAILROAD CO.
CPLT	141	CAMINO, PLACERVILLE & LAKE TAHOE RR CO.
CPTC	149	CHICAGO PRODUCE TERMINAL CO.
CR	190	CONSOLIDATED RAIL CORP.
CRE	189	CONSOLIDATED RAIL CORP. (EASTERN DISTRICT)
CRI	143	CONSOLIDATED RAIL CORP.
CRN	106	CAROLINA & NORTHWESTERN RWY. CO.
CRP		CENTRAL RR OF PENNSYLVANIA
CS	157	THE COLORADO & SOUTHERN RWY. CO.
CSL	147	CHICAGO SHORT LINE RWY. CO.
CSP		CAMAS PRAIRIE RR CO.
CSS	168	CHICAGO SOUTH SHORE & SOUTH BEND RR
CSSL	090	CANADA STEAMSHIP LINES
CTN	097	CANTON RAILROAD CO.
CURB	184	CURTIS BAY RR CO.
CUST	951	CHICAGO UNION STATION CO.
CUVA	186	THE CUYAHOGA VALLEEY RWY. CO.
CV	120	CENTRAL VEERMONT RWY. CO.
CW	158	THE COLORADO & WYOMING RWY. CO.
CWC	095	SEABOARD COAST LINE RR (CHARLESTON & WEST. CAROLINA)
CWI	132	CHICAGO & WESTEN INDIANA RR CO.
CWP	172	CHICAGO, WEST PULLMAN & SOUTHERN RR CO.
CWR	100	CALIFORNIA WESTERN RR
CZ		COAHULIA & ZACATECAS RW.
DA	209	CP RAIL (CANADIAN PAC. LTD.)(DOM. ATL. RWY. CO.)
DC	196	DELRAY CONNECTING RAILROAD COMPANY
DCI	362	DES MOINES & CENTRAL IOWA RAILWAY CO.
DH	195	DELAWARE & HUDSON RAILWAY CO.
DKS	210	DONIPHAN, KENSETT & SEARCY RWY.
DLC		DRUMMOND LIGHTERAGE
DM	204	DETROIT & MACKINAC RWY. CO.
DMIR	213	DULUTH, MISSABE & IRON RANGE RWY. CO.
DMM	220	THE DANSVILLE AND MOUNT MORRIS RR CO.
DMU	202	DES MOINES UNION RWY. CO.
DNE	212	DULUTH & NORTHEASTERN RR CO.
DQE	200	DE QUEEN & EASTERN RR CO.
DR	191	DARDANELLE & RUSSELLVILLE RR CO.
DRGW	197	THE DENVER & RIO GRANDE WESTEN RR CO.
DRI	192	DAVEENPORT, ROCK ISLAND & NORTHWESTEEN RWY. CO.
DS	217	DURHAM & SOUTHERN RWY. CO.
DT	219	DETROIT TERMINAL RR CO.
DTI	208	DETROIT, TOLEDO & IRONTON RR CO.
DTS	205	THE DETROIT AND TOLEDO SHORE LINE RR CO.
DUTC	959	DALLAS UNION TERMINAL
DVR	711	CAPE BRETON DEV. CORP. (COAL DIV.) DEVCO RWY.
DVS	193	DELTA VALLEY & SOUTHERN RWY. CO.
DW		DETROIT & WESTERN
DWML		DUE WEST MOTOR LINE
DWP	216	DULUTH, WINNIPEG & PACIFIC RWY.
EACH	242	EAST CAMDEN & HIGHLAND RR. CO.
EDW	247	EL DORADO & WESSON RWY. CO.
EEC	229	EAST ERIE COMMERCIAL RR

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EJE	238	ELGIN, JOLIET & EASTERN RWY. CO. (CHIC. & OUTER BELT)
EJR	245	EAST JERSEY RR AND TERMINAL CO.
EL	240	CONSOLIDATED RAIL CORP.
ELS	241	ESCANABA & LAKE SUPERIOR RR CO.
EM		EDGEMOOR & MANETTA RWY.
EN	246	ESQUIMALT & NANAIMO RWY. CO.
ETL	228	THE ESSEX TERMINAL RWY. CO.
ETWN	234	EAST TENNESSEE & WESTERN N.C. RR CO.
EV	231	THE EVERETT RR CO.
FBL	508	FEDERAL BARGE LINES
FCDN		FERROCARRIL DE NACOZARI, SCT.
FCIN	272	FRANKFORT & CINCINNATI RR CO.
FCM	275	FERROCARRIL MEXICANO (MEXICAN)
FCP	738	FERROCARRIL DEL PACIFICO, S.A. DE C.V. (PAC FC DEL P)
FDDM	266	CHIC. & NW TRANSP. CO. (FT. DODGE,DES MOINES & SOUTH RWY.)
FCMA	473	FERROCARRIL DE MINATITAN AL CARMEN
FEC	263	FLORIDA EAST COAST RWY. CO.
FERR		FELICIANA EASTERN RR CO.
FJG	264	FONDA, JOHNSTOWN & GLOVERSVILLE RR CO.
FLT		FOSS LAUNCH & TUG
FMS	276	FORT MYERS SOUTHERN RR CO.
FOR	282	FORE RIVER RR CORP.
FP	265	FORDYCE & PRINCETON RR CO.
FPE	260	FAIRPORT, PAINSVILLE & EASTERN RWY. CO.
FRDN	273	FERDINAND RR CO.
FSUD	952	FORT STREEET UNION DEPOT CO.
FSVB	279	FT. SMITH & VAN BUREN RWY. CO.
FWB	277	FT. WORTH BELT RWY. CO.
FWD	268	FT. WORTH & DENVER RWY. CO.
FWU	274	FT. WAYNE UNION
GA	299	GEORGIA RR CO.
GANO	298	THE GEORGIA NORTHERN RWY. CO.
GBW	312	GREEN BAY & WESTERN RR CO.
GC	289	GRAHAM CTY. RR CO.
GCW	287	THE GARDEN CITY WESTERN RWY. CO.
GETY	294	GETTYSBURG RR CO.
GFC		GRAND FALLS CENTRAL RWY. CO., LTD.
GHH	293	GALVESTON, HOUSTON & HENDERSON RR CO.
GJ	321	GREENWICH & JOHNSONVILLE RWY. CO.
GM	290	GAINSVILLE MIDLAND RR CO.
GMO	317	ILLINOIS CENTRAL GULF RR CO. (GULF, MOBLE & OHIO RR CO.)
GMRC	314	GREEN MTN. RR CORP.
GNA	307	GRAYSONIA, NASHVILLE & ASHDOWN RR CO.
GNWR	320	GENESEE & WYOMING RR CO.
GRN	306	GREENVILLE & NORTHERN RWY. CO.
GRNR	322	THE GRAND RIVER RWY. CO.
GRR	302	GEORGETOWN RR CO.
GSF	300	GEORGIA SOUTHERN & FLORIDA RWY. CO.
GSW	305	GREAT SOUTHWEST R.R., INC.
GTC		GULF TRANSPORT
GTW	308	GRAND TRUNK WESTERN RR CO.
GU	323	GRAFTON & UPTON RR CO.
GWF	303	GALVESTON WHARVES
GWIN	319	GOODWIN RR INC.
GWR	311	THE GREAT WESTERN RWY. CO.
HB	330	HAMPTON & BRANCHVILLE RR CO.
HBS	329	HOBOKEN SHORE RR

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HBT	342	HOLSTON BELT & TERMINAL RWY. CO.
HCRC	326	HILLSDALE CTY. RWY. CO., INC.
HDM		HUDSON & MANHATTAN
HE	328	HOLLIS & EASTERN RR CO.
HI	339	HOLTON INTER-URBAN RWY. CO.
HLNE	338	HILLSBORO & NORTH EASTERN RWY. CO.
HMR	335	HOBOKEN MANUFACTURERS
HN	332	THE HUTCHINSON & NORTHERN RWY. CO.
HPTD	366	HIGH POINT, THOMASVILLE & DENTON RR CO.
HRDL		HUDSON RIVER DAY LINE
HRT	334	HARTWELL RWY. CO.
HS	336	HARTFORD & SLOCOMB RR CO.
HSW	331	HELENA SOUTHWESTERN RR CO.
HT		HOWARD TERMINAL
HUBA		HUDSON BAY
IAT	513	IOWA TEMINAL RR CO.
IBT	358	THE INTENATONAL BRIDGE & TERMINAL CO.
IC	351	ILLINOIS CENTRAL GULF RR CO. (ILLINOIS CENTRAL)
ICG	350	ILLINOIS CENTRAL GULF RR CO.
IGN		INTERNATIONAL-GREAT NORTHERN
IHB	357	INDIANA HARBOR BELT RR CO.
INT	361	INTESTATE RR CO.
IRN	364	CONSOLIDATEED RAIL CORP.
ISU		IOWA SOUTHERN UTILITIES (SOUTHERN INC. RR, INC.)
ITB		ISLAND TUG AD BARGEE
ITC	354	ILLINOIS TERMINAL RR CO.
IU	353	INDIANAPOLIS UNION
JE		JERSEYVILLE & EASTERN
JGS		JAMES GRIFFITHS & SONS
JSC		JOHNSTOWN & STONY CREEK RR CO.
JTCO	953	JACKSONVILLE TERMINAL CO.
KC	410	THE KANAWHA CENTRAL RWY. CO.
KCC		KANSAS CITY CONNECTING RR CO.
KCMO		KANSAS CITY, MEXICO & ORIENT
KCNW	411	KELLEY'S CREEK & NORTHWESTERN RR CO.
KCS	400	THE KANSAS CITY SOUTHERN RW. CO.
KCT	401	KANSAS CITY TERMINAL RWY. CO.
KCWB		KANSAS CITY WESTPORT BELT
KENN	403	KENNECOTT COMPANY RR
KIT	402	KEENTUCKY & INDIANA TERMINAL RR CO.
KM	414	THE KANSAS & MISSOURI RWY. & TERMINAL CO.
KNC	412	KINGCOME NAVIGATION
KNOR		KLAMATH NORTHERN RWY. CO.
KT	405	KEENTUCKY & TENNESSEE RWY.
LA	441	LOUISIANA & ARKANSAS RWY. CO.
LAJ	428	LOS ANGELES JUNCTION RWY. CO.
LAL	398	LIVONIA, AVON & LAKEVILLE RR CORP.
LAPT	954	LOS ANGELES UNION PASSENGER TERMINAL
LASB	409	LACKAWAXEN & STOURBRIDGE RR CORP.
LAWV	437	THE LORAIN & WEST VIRGINIA RWY. CO.
LBR	447	THE LOWVILLE & BEAVER RIVER RR CO.
LC	426	LANCASTEER & CHESTER RWY. CO.
LCCE		LEE COUNTY CENTRAL ELECTRIC
LDRT	407	THE LAKE FRONT DOCK & RR TERMINAL CO.
LDTC	439	LAWNDALE TRANSPORTATON CO.
LE		LOUISIANA EASTERN RR
LEE	406	THE LAKE ERIE & EASTERN RR CO.

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LEF	423	LAKE ERIE, FRANKLIN & CLARION RR CO.
LEFW	424	LAKE ERIE & FT. WAYNE RR CO.
LEN	42L	THE LAKE ERIE & NORTHERN RWY. CO.
LHR	429	CONSOLIDATED RAIL CORP.
LI	436	THE LONG ISLAND RR CO.
LM	127	LITCHFIELD & MADISON (CHIC. & N.W. TRANSP. CO.)
LMT	488	LOUISIANA MIDLAND TRANSPORT
LN	444	LOUISVILLE & NASHVILLE RR CO.
LNAC	446	LOUISVILLE, NEW ALBANY & CORYDON RR CO.
LNE	413	CONSOLIDATED RAIL CORP.
LNO	434	LAONA & NORTHERN RWY. CO.
LNW	442	THE LOUISIANA & NORTHWEST RR CO.
LOAM	448	LOUISIANA MIDLAND RWY. CO.
LPB	443	THE LOUISIANA & PINE BLUFF RWY. CO.
LPN	450	LONGVIEW, PORTLAND & NORTHERN RWY. CO.
LPSG		LIVE OAK, PERRY & S. GEORGIA RWY. CO.
LRPA	435	LITTLE ROCK PORT RR
LRS	427	LAURINBURG & SOUTHERN RR CO.
LSBC	420	THE LA SALLE & BUREAU CTY. RR CO.
LSI	425	LAKE SUPERIOR & ISHPEMING RR CO.
LSO	445	LOUISIANA SOUTHERN RWY. CO.
LSTT	417	LAKE SUPERIOR TEMINAL & TRANSFER RWY. CO.
LT	404	THE LAKE TERMINAL RR CO.
LTC	422	LAFFERTY TRANSPORTATION
LUN	430	LUDINGTON & NORTHERN RWY.
LV	431	CONSOLIDATED RAIL CORP.
LW	451	LOUISVILLE & WADLEY RWY. CO.
LWV	419	CONSOLIDATED RAIL CORP.
MAA		MAGMA ARIZONA RR CO.
MAYW	469	MAYWOOD & SUGAR CREEK
MB	509	MONTPELIER & BARRE RR CO.
MBRR		MERIDAN & BIGBEE RR CO.
MBT	468	MARIANNA & BLOUNTSTOWN RR CO.
MC	472	CONSOLIDATED RAIL CORP.
MCER	461	MASSACHUSEETTS CENTRAL
MCR	466	MC CLOUD RIVER RR CO.
MCRR	498	THE MONONGAHELA CONNECTING RR CO.
MCSA	548	MOSCOW, CAMDEN & SAN AUGUSTINE RR
MD	465	MUNICIPAL DOCKS
MDP	285	MEXICANN PACIFIC RR CO.,INC. (FERROCARRIL MEX.DEL PACIFICO)
MDRY	455	MADISON RWY. CO., INC.
MDW	510	MINNESOTA, DAKOTA & WESTERN RWY. CO.
ME	511	MORRISTOWN & ERIE RR CO.
MEC	456	MAINE CENTRAL RR CO.
MET		MODESTO & EMPIRE TRACTION CO.
METW	523	MUNICIPALITY OF EAST TROY, WISCONSIN
MF		MIDDLE FORK
MG		THE MOBILE & GULF RR CO.
MGA	497	THE MONONGAHELA RWY. CO.
MGRS	292	FERROCARRILES NACIONALES DE MEXICO (NAT'L. RWYS OF MEXICO)
MH	552	MOUNT HOOD RWY. CO.
MHCO	584	MARQUETTE & HURON MTN. RR CO., INC.
MHM	581	CONSOLIDATED RAIL CORP.
MI	515	MISSOURI-ILLINOIS RR CO.
MID		MIDWAY
MIDH	479	MIDDLETOWN & HUMMELSTOWN RR CO.
MIGN	50L	MICHIGAN NORTHERN RWY. CO., INC.

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MILW	140	CHICAGO, MILWAUKEE, ST. PAUL & PACIFIC RR CO.
MINE	474	MINNEAPOLIS EASTERN RWY. CO.
MIR	522	MINNEAPOLIS INDUSTRIAL RWY. CO.
MISS	502	MISSISSIPPIAN
MJ	459	MANUFACTURERS' JUNCTION RWY. CO.
MKC	583	MCKEESPORT CONNECTING RR CO.
MKT	490	MISSOURI-KANSAS-TEXAS RR CO.
MLD		MIDLAND
MLST		MILSTEAD
MNJ	475	MIDDLETOWN & NEW JERSEY RWY. CO., INC.
MNS	480	MINNEAPOLIS, NORTHFIELD & SOUTHERN RWY.
MOT		MARINE OIL TRANSPORTATION
MCTC		MONTREAL TRAMWAYS
MCV	507	MOSHASSUCK VALLEY RR CO.
MP	494	MISSOURI PACIFIC RR CO.
MPA	463	MARYLAND & PENNA. RR CO.
MRS	460	MANUFACTURERS RWY. CO.
MSE	506	MISSISSIPPI EXPORT RR CO.
MSLC	486	MINNESOTA SHORT LINES CO.
MSTR	471	THE MASSENA TERMINAL RR CO.
MSV	503	MISSISSIPPI & SKUNA VALLEY RR CO.
MTC	467	MYSTIC TERMINAL CO.
MTCO	955	MACON TERMINAL CO.
MTFR	484	THE MINNESOTA TRANSFER RWY. CO.
MTR	500	MONTOUR RR CO.
MTW	520	MARINETTE, TOMAHAWK & WESTERN RR
MUSC	961	MEMPHIS UNION STATON CO.
MVT		MT. VERNON TEMINAL
MWR	464	MUNCIE & WESTERN RR CO.
MWRC	962	MT. WASHINGTON RWY. CO.
NAP	525	THE NARRAGANSETT PIER RR CO., INC.
NAR	563	NORTHERN ALBERTA RAILWAYS CO.
NB	554	NORTHAMPTON AND BATH RR CO.
NBST	567	THE NEW BRAUNFELS & SERVTEX RR CO.
NC	449	LOUISVILLE & NASHVILLE RR CO. (NASHVLE, CHATANOOGA & ST. LOUIS)
NCAN	356	INCAN SUPERIOR LTD.
NCM	286	FERROCARRILES NACIONALES DE MEX(NATL.RWYS.OF MEX.)(CARS MKD.NDEM)
NCT	291	FERROCARRIL NACIONAL DE TEHUANTEPEC(TEHUANTEPEC NAT'L.)
NEZP	537	NEZPERCE RR CO.
NFD	582	NORFOLK, FRANKLIN & DANVILLE RWY. CO.
NHIR	585	NEW HOPE & IVYLAND RR CO.
NIAJ	538	CONSOLIDATED RAIL CORP.
NJ	562	NAPIERVILLE JUNCTION RWY. CO.
NJII	533	N.J., INDIANA & ILLINOIS RR CO.
NLC	534	NEW ORLEANS & LOWER COAST RR CO.
NLG	553	NORTH LOUISIANA & GULF RR CO.
NN	530	NEVADA NORTHERN RWY. CO.
NCDM		MEXICO NORTHWESTERN
NOKL	591	NORTHWESTERN OKLAHOMA RR CO.
NOPB	536	NEW ORLEANS PUBLIC BELT RR
NCRM		NORMETAL
NCT	960	NEW ORLEANS TERMINAL
NCTM		NEW ORLEANS, TEXAS & MEXICO
NPB	549	NORFOLK & PORTSMOUTH BELT LINE RR CO.
NPT	964	PORTLAND TERMINAL RR CO. (ORE.)
NS	551	NORFOLK SOUTHERN RWY. CO.
NSC		NEWTEX S.S.
NSCT		NIAGARA, ST. CATHARINES & TORONTO
NSRC	570	NORTH STRATFORD RR CORP.

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NSS	577	THE NEWBURGH & SOUTH SHORE RWY. CO.
NW	550	NORFOLK & WESTERN RWY. CO. (N & W DIST.)
NWP	559	NORTHWESTERN PACIFIC RR CO.
NYCN		NEW YORK CONNECTING RR
NYD	542	NEW YORK DOCK RWY.
NYLB	539	CONSOLIDATED RAIL CORP.
NYSW	546	N.Y.,SUSQUEHANNA & WEST. RR CO. (WALTER G. SCOTT,TRUSTEE)
OCE	603	OREGON, CALIF., & EASTERN RWY. CO.
OCTR	587	OCTORARO RWY. INC.
OE	600	OREGON ELECTRIC RWY. CO.
OLB	598	OMAHA, LINCOLN & BEATRICE RWY. CO.
OMLP		OHIO MIDLAND LIGHT & POWER
CNRY	592	OGDENSBURG BRIDGE & PORT AUTHORITY
ONT	754	ONTARIO NORTHLAND RWY.
ONW	596	OREGON & NORTHWESTERN RR CO.
OPE	597	OREGON, PACIFIC & EASTERN RWY. CO.
OR	604	OWASCO RIVER
OT	601	OREGON TRUNK RAILWAY
OTR	586	TE OAKLAND TERMINAL RWY.
OURD	956	THE OGDEN UNION RWY. & DEPOT CO.
PAE	615	CONSOLIDATED RAIL CORP.
PAM	607	PGH., ALLEGHENY & MCKEES ROCKS RR CO.
PAUT		CONSOLIDATED RAIL CORP.
PBL		THE PHILADELPHIA BELT LINE RR CO.
PBNE	659	PHILA., BETHLEHEM & NEW ENGLAND RR CO.
PBR	609	PATAPSCO & BACK RIVERS RR CO.
PBVR	677	THE FORT BIENVILLE RR
PC	622	CONSOLIDATED RAIL CORP.
PCN	651	POINT COMFORT & NORTHERN RWY. CO.
PCY	629	PGH., CHARTIERS & YOUGHIOGHENY RWY. CO.
PER		PORT EVERGLADES RWY.
PF	630	THE PIONEER & FAYETTE RAILROAD CO.
PFE	595	PACIFIC FRUIT EXPRESS CO.
PHD	647	PORT HURON AD DETROIT RR CO.
PI	614	PADUCAH & ILLINOIS RR
PICK	624	THE PICKENS RR CO.
PJR	648	PORT JERSEY
PLE	626	THE PITTSBURGH & LAKE ERIE RR CO.
PM	610	THE CHESAPEAKE & OHIO RWY. CO. (PERE MARQUETTE DIST.)
PMKY		PITTSBURGH, MCKEESPORT & YOUGHIOGHENY
PNS	640	PHILADELPHIA & NORFOLK STEAMSHIP
PNW	634	THE PRESCOTT & NORTHWESTERN RR CO.
POV	616	PITTSBURGH & OHIO VALLEY RWY. CO.
PPBD		PORT OF PALM BEACH DISTRICT
PPU	645	PEORIA & PEKIN UNION RWY. CO.
PRSL	027	CONSOLIDATED RAIL CORP.
PRT	606	PARR TERMINAL RR
PRTD	632	PORTLAND TRACTION CO. (PORTLAND RR & TERMINAL DIV.)
PRV	636	PEARL RIVER VALLEY RR CO.
PS	627	THE PGH. & SHAWMUT RR CO.
PSFL		PUGET SOUND FREIGHT LINES
PSR	639	PETALUMA & SANTA ROSA RR CO.
PST		PHILADELPHIA SUBURBAN TRANSPORTATION
PSTB		PUGET SOUND TUG & BARGE
PT		PENINSULA TERMINAL CO.
PTC	646	PEORIA TERMINAL CO.
PTM	619	PORTLAND TERMINAL CO. (ME.)
PTRR		PORT TOWNSEND RR, INC.
PLCC		PORT UTILITIES

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PVS	644	THE PECOS VALLEY SOUTHERN RWY. CO.
PW	631	PROVIDENCE & WORCESTER CO.
QAP	655	QUANAH, ACME & PACIFIC RW. CO.
QC	658	QUEBEC CENTRAL RAILWAY CO.
QRR	656	QUINCY RR CO.
RC		ROSSLYN, CONNECTING RR CO.
RCG	623	CONSOLIDATED RAIL CORP.
RFP	663	RICHMOND, FREDERICKSBURG & POTOMAC RR CO.
RI	145	CHICAGO, ROCK ISLAND & PACIFIC RR CO.
ROR	676	ROCKTON & RON RWY.
RR	671	RARITAN RIVER RAIL ROAD CO.
RS	669	THE ROBERVAL AND SAGUENAY RWY. CO.
RSB	662	ROCHESTER SUBWAY
RSP	673	ROSCOE, SNYDER & PACIFIC RWY. CO.
RSS	675	ROCKDALE, SANDOW & SOUTHERN RR CO.
RT	665	THE RIVER TERMINAL RAILWAY CO.
RTM	666	THE RAILWAY TRANSFER CO. OF TE CITY OF MINNEAPOLIS
RV	664	RAHWAY VALLEY R.R. RAHWAY VALLEY CO., LESSEE
SAN	691	SANDERSVILLE RR CO.
SB	791	SOUTH BUFFALO RAILWAY CO.
SBC	283	FERROCARRIL SONORA BAJA CALIF., S.A. DE C.V.
SBK	718	SOUTH BROOKLYN RWY. CO.
SBM		ST. LOUIS, BROWNSVILLE & MEXICO
SC	681	SUMTER & CHOCTAW RWY. CO.
SCL	712	SEABOARD COAST LINE RR CO.
SCM	687	STROUDS CREEK & MUDDLETY RR
SCT	735	SIOUX XITY TERMINAL RWY.
SDAE	702	SAN DIEGO & ARIZONA EASTERN RWY. CO.
SEE	281	FERROCARRILES UNIDOS DEL SURESTE, S.A. DE C.V.
SERA	716	SIERRA RAILROAD CO.
SFPP		SPRUCE FALL POWER & PAPER
SH	799	STEELTON & HIGHSPIRE RR CO.
SI	727	SPOKANE INTERNATIONAL RR CO.
SIND	720	SOUTHERN INDIANA RWY., INC.
SIRC		THE STATEN ISLAND RR CORP.
SIRR	367	SOUTHERN INDUSTRIAL RR INC.
SJB	680	ST. JOSEPH BELL RWY. CO.
SJL	793	ST. JOHNSBURY & LAMOILLE CTY. RR.
SJRT	685	ST. JOHNS RIVER TERMINAL
SJT	683	ST. JOSEPH TERMINAL RR CO.
SLAW	705	ST. LAWRENCE RR, DIV. OF NAT'L. RWY. UTILIZATON CORP.
SLC	696	THE SAN LUIS CENTRAL RR CO.
SLGW	690	SALT LAKE, GARFIELD & WESTERN RWY. CO.
SLS		SEA-LAND SERVICE, INC.
SLSF	693	ST. LOUIS-SAN FRANCISCO RWY. CO.
SM	682	ST.MARY'S RR CO.
SMA	794	SAN MANUEL ARIZONA RR CO.
SMV	741	SANTA MARIA VALLEY RR CO.
SN	697	SACRAMENTO NORTHERN RWY.
SNBL		SIOUX CITY & NEW ORLEANS BARGE LINE
SNCO		SEAPORT NAVIGATION
SOO	482	SOO LINE RR CO.
SOPR	736	SOUTH PIERCE RR
SOT	792	SOUTH OMAHA TERMINAL RWY. CO.
SOU	724	SOUTHERN RWY. SYSTEM
SP	721	SOUTHERN PACIFIC TRANSPORTATION CO.
SPUD	957	ST. PAUL UNION DEPOT CO.
SRC	686	STRASBURG RR CO.
SRN	678	SABINE RIVER & NORTHERN RR CO.

1. Uniform Alpha Code

2. ACI Code

3. Railroad Company Name

1	2	3
SRN	678	SABINE RIVER & NORTHERN RR CO.
SS	707	SAND SPRINGS RWY. CO.
SSDK	679	SAVANNAH STATE DOCKS RR CO.
SSH	704	SOUTH SHORE
SSL		SKANEATELES SHORT LINE RR CORP.
SSLV	706	SOUTHERN SAN LUIS VALLEY RR CO.
SSW	694	ST. LOUIS SOUTHWESTERN RWY. CO.
ST		SPRINGFIELD TERMINAL RWY. CO. (VERMONT)
STE	739	STOCKTON TERMINAL & EASTERN RR
STL	714	SEATRAIN LINES, INC.
STRT	729	THE STEWARTSTOWN RR CO.
SUN	734	SUNSET RAILWAY CO.
SUR	578	SUN OIL CO. OF PENNA.
TAEA		TANGIPAHOA & EASTERN
TAG	755	TENNESSEE, ALABAMA & GA. RWY. CO.
TAS		TAMPA SOUTHERN RR
TASD	758	TERMINAL RWY., ALABAMA STATE DOCKS
TAW	785	THE TOLEDO, ANGOLA & WESTERN RWY. CO.
TB	798	TWIN BRANCH RR CO.
TCG	783	TUSCON, CORNELIA & GILA BEND RR CO.
TCT	761	TEXAS CITY TERMINAL RWY. CO.
TEM		TEMISKAMING & NORTHERN ONTARIO
TENN	767	TENNESSEE RAILWAY CO.
TEXC	750	TEXAS CENTRAL RR CO.
THB	774	THE TORONTO, HAMILTON & BUFFALO RWY. CO.
TM	762	THE TEXAS MEXICAN RWY. CO.
TMBL	759	TACOMA MUNICIPAL BELT LINE RWY.
TN	795	TEXAS & NORTHERN RWY. CO.
TNM	788	TEXAS-NEW MEXICO RWY. CO.
TOE	764	TEXAS, OKLAHOMA & EASTERN RR CO.
TOV	782	TOOELE VALLEY RWY. CO.
TP	760	MISSOURI PACIFIC RR CO.
TPMP	763	TEXAS PACIFIC-MISSOURI PACIFIC TERMINAL RR OF N. ORLEAS
TPT	778	CONSLIDATED RAIL CORP.
TPW	769	TOLEDO, PEORIA & WESTERN RR CO.
TRC	779	TRONA RWY. CO.
TRRA	757	TERMINAL RR ASSOC. OF ST. LOUIS
TS	784	TIDEWATER SOUTHERN RWY. CO.
TSE	765	TEXAS SOUTH-EASTERN RR CO.
TSU	709	TULSA-SAPULPA UNION RWY. CO.
TT	771	THE TOLEDO TERMINAL RR CO.
TTR		TIJUANA & TECATE RWY. CO.
TUST	958	TEXARKANA UNION STATION TRUST
TYC	796	TYLERDALE CONNECTING
UCR		UTAH COAL ROUTE
UMP	808	UPPER MERION & PLYMOUTH RR CO.
UNI	805	UNITY RWYS. CO.
UO		UNION RR OF OREGON
UP	802	UNION PAC. RR CO.(OREGON SHORT LINE;ORE.-WASH RR & NAVIGAT.)
URR	803	UNION RR CO. (PITTSBURGH, PA.)
URY	804	UNION RY. OF MEMPHIS
UT	807	UNION TERMINAL RWY. (OF ST. JOSEPH, MO.)
UTAH	811	UTAH RWY. CO.
UTR	809	UNION TRANSPORTATION
VALE	814	THE VALLEY RR CO.
VAMD	815	VIRGINIA & MARYLAND RR
VBR	819	VIRGINIA BLUE RIDGE RWY.
VC	820	VIRGINIA CENTRAL RWY.
VCY	821	VENTURA CTY. RWY. CO.

1. Uniform Alpha Code

2. ACI Code

3. Railroad Company Name

1	2	3
VE	824	VISALIA ELECTRIC RR CO.
VNCR	822	VERMONT NORTHERN RR CO.
VS		VALLEY AND SILETZ RR CO.
VSO	816	VALDOSTA SOUTHERN RR
VTR	817	VERMONT RWY. INC.
WA	841	THE WESTERN RWY. OF ALABAMA
WAG	848	WELLSVILLE, ADDISON & GALETON RR CORP.
WAL	834	WESTERN ALLEGHENY RR CO.
WAR	827	WARRENTON RR CO.
WAS		WAYNESBURG SOUTHERN
WATC	849	THE WASHINGTON TERMINAL CO.
WATR		WATERVILLE
WAW		CONSOLIDATED RAIL CORP.
WBC		WILKES-BARRE CONNECTING RR
WBTS	867	WACO, BEAUMONT, TRNITY & SABINE RWY CO.
WCTR	844	WCTU RWY. CO.
WHN	842	CONSOLIDATED RAIL CORP.
WIF		WEST INDIA FRUIT & STEAMSHIP
WIM	831	WASHINGTON, IDAHO & MONTANA RWY. CO.
WLE		WHEELING & LAE ERIE
WLFB	869	WOLFEBORO RR CO., INC.
WLO	835	WATERLOO RR CO.
WM	839	WESTERN MARYLAND RWY. CO.
WMSC	847	WHITE MOUNTAIN SCENIC RR
WMWN	837	THE WEATHERFORD, MINEAL WELLS & NORTHWESTEN RWY. CO.
WNF	851	THE WINFIELD RR CO.
WNFR	852	WINFREDE RR CO.
WOV	829	WARREN & OUACHITA VALLEY RWY. CO.
WP	840	THE WESTERN PACIFIC RR CO.
WPY	845	WHITE PASS & YUKON ROUTE
WRRC	838	WESTERN RAIL ROAD CO.
WRWK	797	WARWICK RWY. CO.
WS	828	WARE SHOALS RR C.
WSB	832	WARREN & SALINE RIVER RR CO.
WSS	854	WINSTON-SALEM SOUTHBOUND RWY. CO.
WSYP	846	WHITE SULPHUR SPRINGS & YELLOWSTONE RWY. CO.
WT		WELDWOOD TRANSPORTATION LTD.
WTCO		WESTERN TRANSPORTATION CO.
WTOH	865	WESTERN OHIO RR CO.
WVN	866	WEST VIRGINIA NORTHERN RR C.
WW	850	WINCHESTER & WESTERN RR CO.
WWR		WAHINGTON WESTERN
WWV	826	WALLA WALLA VALLEY RWY. CO.
WYS	830	WYANDOTTE SOUTHEERN RR C.
WYT	833	WYANDOTTE TERMINAL RR CO.
YAN	876	YANCEY RR C.
YN	877	THE YOUNGSTOWN & NORTHERN RR CO.
YS	875	YOUNGSTOWN & SOUTHERN RWY. CO.
YVT	872	YAKIMA VALLEY TRANSPORTATION CO.
YW	873	YREKA WESTERN RR CO.

1. Uniform Alpha Code
2. ACI Code
3. Railroad Company Name

APPENDIX G

FINANCIAL RATIO ANALYSIS BY RAILROAD COMPANY

This appendix contains the results of the macroeconomic modelling efforts that estimate the changes in price, demand and employment related to each railroad company studied. A computer printout is presented which displays these results along with additional information that links the model outcomes to a particular railroad company and key parameters, specifically unit price, ton-miles and existing number of people employed. The data shown pertains to the year (1976) and the analysis results relate to the identical year. As described in Section 7, two L_{dn} levels are used, specifically $L_{dn}70$ and $L_{dn}65$. Related to each analyzed regulatory study level are two price elasticities of demand; these are -0.93 and -1.41. or a given L_{dn} value and price elasticity of demand, three specific results are calculated from application of the model; these are (a) the percentage price increase, (b) the percentate ton-miles decrease and (c) the employment decrease or number of employees idled. Hence, there are a total of 2 groups of 3 results each computed for a specific L_{dn} regulatory study level.

The legend for class/region is as follows:

000 = Class II/region, not specified
011 = Class I/Eastern region
012 = Class I/Southern region
013 = Class I/Western region.

When an asterisk appears in a given row or column, this means that the data was not available about the firm for which the calculation was attempted or the information was not available in the existing literature.

Legend

1. Class Region

2. ACI Code

3. Uniform Alpha Code

4. 1976 Data

(a) Unit Price ¢/ton-mile	(b) Ton-miles 10^6	(c) Existing Employment Level

5. L_{dn} 70 dBA
$\varepsilon_d = -0.39$

(a) % Price Increase	(b) % Ton-miles Decrease	(c) Employment Decrease

6. L_{dn} 70 dBA
$\varepsilon_d = -1.41$

(a) % Price Increase	(b) % Ton-miles Decrease	(c) Employment Decrease

7. L_{dn} 65 dBA
$\varepsilon_d = -0.39$

(a) % Price Increase	(b) % Ton-miles Decrease	(c) Employment Decrease

8. L_{dn} 65 dBA
$\varepsilon_d = -1.41$

(a) % Price Increase	(b) % Ton-miles Decrease	(c) Employment Decrease

1	2	3	4			5			6			7			8		
			(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
000	3	ACY	6.5	121.	262.	0.5	0.2	0.	0.6	0.8	2.	5.5	2.1	5.	6.7	9.5	22.
000	2	ABB	*	0.	40.	*	*	*	*	*	*	*	*	*	*	*	*
000	11	APA	*	0.	58.	*	*	*	*	*	*	*	*	*	*	*	*
000	10	AA	2.3	379.	0.	0.1	0.0	0.	0.1	0.1	0.	4.7	1.8	0.	3.9	5.5	0.
000	9	AR	*	0.	59.	*	*	*	*	*	*	*	*	*	*	*	*
000	4	AWW	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	21	ADN	*	0.	70.	*	*	*	*	*	*	*	*	*	*	*	*
000	20	AMR	*	0.	16.	*	*	*	*	*	*	*	*	*	*	*	*
000	19	AMC	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	18	ALQS	*	0.	513.	*	*	*	*	*	*	*	*	*	*	*	*
000	16	ALM	*	0.	62.	*	*	*	*	*	*	*	*	*	*	*	*
000	14	ABL	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	13	ARA	*	0.	12.	*	*	*	*	*	*	*	*	*	*	*	*
000	12	AN	*	0.	102.	*	*	*	*	*	*	*	*	*	*	*	*
000	65	BS	*	0.	314.	*	*	*	*	*	*	*	*	*	*	*	*
000	64	BOCT	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	49	ARC	*	0.	C.	*	*	*	*	*	*	*	*	*	*	*	*
000	42	ASAB	*	0.	164.	*	*	*	*	*	*	*	*	*	*	*	*
000	39	AVL	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	35	ANR	*	0.	23.	*	*	*	*	*	*	*	*	*	*	*	*
000	32	ALS	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	31	AEC	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	23	AWP	*	0.	155.	*	*	*	*	*	*	*	*	*	*	*	*
000	204	DM	*	0.	147.	*	*	*	*	*	*	*	*	*	*	*	*
0C0	202	DMU	*	0.	85.	*	*	*	*	*	*	*	*	*	*	*	*
000	201	CCR	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	200	DQE	*	0.	144.	*	*	*	*	*	*	*	*	*	*	*	*
000	195	DC	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	193	DVS	*	0.	6.	*	*	*	*	*	*	*	*	*	*	*	*
000	192	DRI	*	0.	90.	*	*	*	*	*	*	*	*	*	*	*	*
000	191	DR	*	0.	19.	*	*	*	*	*	*	*	*	*	*	*	*
000	188	CLCO	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	186	CUVA	*	0.	306.	*	*	*	*	*	*	*	*	*	*	*	*
000	181	CLIF	*	0.	2.	*	*	*	*	*	*	*	*	*	*	*	*
000	179	CHW	*	0.	24.	*	*	*	*	*	*	*	*	*	*	*	*
000	177	CAGY	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	169	CLP	*	0.	3.	*	*	*	*	*	*	*	*	*	*	*	*
000	168	CSS	*	0.	305.	*	*	*	*	*	*	*	*	*	*	*	*
000	166	COP	*	0.	24.	*	*	*	*	*	*	*	*	*	*	*	*
000	165	*	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	163	CLC	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	158	CW	*	0.	218.	*	*	*	*	*	*	*	*	*	*	*	*
000	153	CNTP	1.8	6215.	0.	0.1	0.0	0.	0.2	0.3	0.	0.2	0.1	0.	0.4	0.6	0.
000	150	CIW	*	0.	24.	*	*	*	*	*	*	*	*	*	*	*	*
000	147	CSL	*	0.	47.	*	*	*	*	*	*	*	*	*	*	*	*
000	141	CPLT	*	0.	6.	*	*	*	*	*	*	*	*	*	*	*	*
000	139	CHTT	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	130	CIM	*	0.	409.	*	*	*	*	*	*	*	*	*	*	*	*
000	124	CHV	*	0.	21.	*	*	*	*	*	*	*	*	*	*	*	*
000	118	CGA	2.2	4677.	C.	0.2	0.1	0.	0.2	0.3	0.	1.3	0.5	0.	1.9	2.7	0.

			4			5			6			7			8		
1	2	3	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
000	117	CHR	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	114	CACV	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	113	CARR	*	0.	7.	*	*	*	*	*	*	*	*	*	*	*	*
000	112	CCT	*	0.	48.	*	*	*	*	*	*	*	*	*	*	*	*
000	111	CIC	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	109	*	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	108	*	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	106	CRN	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	104	CBC	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	103	CN	*	0.	82256.	*	*	*	*	*	*	*	*	*	*	*	*
000	101	CI	*	0.	106.	*	*	*	*	*	*	*	*	*	*	*	*
000	100	CWR	*	0.	55.	*	*	*	*	*	*	*	*	*	*	*	*
000	99	CP	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	97	CTN	*	0.	186.	*	*	*	*	*	*	*	*	*	*	*	*
000	92	CAD	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	91	BRDT	*	0.	118.	*	*	*	*	*	*	*	*	*	*	*	*
000	87	BML	*	0.	30.	*	*	*	*	*	*	*	*	*	*	*	*
000	86	*	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	84	BXN	*	0.	35.	*	*	*	*	*	*	*	*	*	*	*	*
000	83	BRC	*	0.	998.	*	*	*	*	*	*	*	*	*	*	*	*
000	81	*	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	79	BH	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	78	BAP	*	0.	145.	*	*	*	*	*	*	*	*	*	*	*	*
000	877	YN	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	876	YAN	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	875	YS	*	0.	18.	*	*	*	*	*	*	*	*	*	*	*	*
000	873	YW	*	0.	8.	*	*	*	*	*	*	*	*	*	*	*	*
000	872	YVT	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	854	WSS	4.1	154.	63.	0.1	0.1	0.	0.3	0.4	0.	4.3	1.7	1.	12.8	18.1	7.
000	851	WNF	*	0.	5.	*	*	*	*	*	*	*	*	*	*	*	*
000	850	WW	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	848	WAG	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	846	WSYP	*	0.	3.	*	*	*	*	*	*	*	*	*	*	*	*
000	841	WA	*	0.	166.	*	*	*	*	*	*	*	*	*	*	*	*
000	838	WRRC	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	833	WYT	*	0.	35.	*	*	*	*	*	*	*	*	*	*	*	*
000	832	WSB	*	0.	12.	*	*	*	*	*	*	*	*	*	*	*	*
000	831	WIM	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	830	WYS	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	829	WOV	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	828	WS	*	0.	8.	*	*	*	*	*	*	*	*	*	*	*	*
000	826	WWV	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	817	VTR	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	815	VAMD	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	811	UTAH	*	0.	84.	*	*	*	*	*	*	*	*	*	*	*	*
000	809	UTR	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	808	UMP	*	0.	86.	*	*	*	*	*	*	*	*	*	*	*	*
000	807	UT	*	0.	55.	*	*	*	*	*	*	*	*	*	*	*	*
000	803	URR	*	0.	1777.	*	*	*	*	*	*	*	*	*	*	*	*
000	799	SH	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*

1	2	3	4 (a)	4 (b)	4 (c)	5 (a)	5 (b)	5 (c)	6 (a)	6 (b)	6 (c)	7 (a)	7 (b)	7 (c)	8 (a)	8 (b)	8 (c)
000	795	TN	*	0.	154.	*	*	*	*	*	*	*	*	*	*	*	*
000	794	SMA	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	793	SJL	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	788	TNM	*	0.	16.	*	*	*	*	*	*	*	*	*	*	*	*
000	785	TAW	*	0.	6.	*	*	*	*	*	*	*	*	*	*	*	*
000	784	TS	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	783	TCG	*	0.	25.	*	*	*	*	*	*	*	*	*	*	*	*
000	782	TOV	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	779	TRC	*	0.	46.	*	*	*	*	*	*	*	*	*	*	*	*
000	771	TT	*	0.	109.	*	*	*	*	*	*	*	*	*	*	*	*
000	767	TENN	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	765	TSE	*	0.	38.	*	*	*	*	*	*	*	*	*	*	*	*
000	761	TCT	*	0.	98.	*	*	*	*	*	*	*	*	*	*	*	*
000	760	TP	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	759	TMBL	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	758	TASD	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	757	TRRA	*	0.	2240.	*	*	*	*	*	*	*	*	*	*	*	*
000	755	TAG	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	750	TEXC	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	746	*	*	0.	12.	*	*	*	*	*	*	*	*	*	*	*	*
000	741	SMV	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	739	STE	*	0.	58.	*	*	*	*	*	*	*	*	*	*	*	*
000	730	*	44.1	4.	0.	0.4	0.2	0.	0.5	0.7	0.	14.2	5.5	0.	25.9	36.5	0.
000	727	SI	*	0.	123.	*	*	*	*	*	*	*	*	*	*	*	*
000	720	SIND	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	719	*	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	718	SBK	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	716	SERA	*	0.	45.	*	*	*	*	*	*	*	*	*	*	*	*
000	709	TSU	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	707	SS	*	0.	44.	*	*	*	*	*	*	*	*	*	*	*	*
000	706	SSLV	*	0.	2.	*	*	*	*	*	*	*	*	*	*	*	*
000	705	SLAW	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	702	SDAE	*	0.	125.	*	*	*	*	*	*	*	*	*	*	*	*
000	700	*	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	697	SN	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	696	SLC	*	0.	9.	*	*	*	*	*	*	*	*	*	*	*	*
000	691	SAN	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	690	SLGW	*	0.	8.	*	*	*	*	*	*	*	*	*	*	*	*
000	683	SJT	*	0.	50.	*	*	*	*	*	*	*	*	*	*	*	*
000	682	SM	*	0.	36.	*	*	*	*	*	*	*	*	*	*	*	*
000	678	SRN	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	675	RSS	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	673	RSP	*	0.	42.	*	*	*	*	*	*	*	*	*	*	*	*
000	671	RR	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	665	RT	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	664	RV	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	659	PBNE	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	656	QRR	*	0.	4.	*	*	*	*	*	*	*	*	*	*	*	*
000	655	QAP	*	0.	21.	*	*	*	*	*	*	*	*	*	*	*	*
000	651	PCN	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*

			4			5			6			7			8		
1	2	3	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
000	648	PJR	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	647	PHD	*	0.	36.	*	*	*	*	*	*	*	*	*	*	*	*
000	645	PPU	*	0.	398.	*	*	*	*	*	*	*	*	*	*	*	*
000	644	PVS	*	0.	17.	*	*	*	*	*	*	*	*	*	*	*	*
000	634	PNW	*	0.	22.	*	*	*	*	*	*	*	*	*	*	*	*
000	632	PRTD	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	631	PW	*	0.	92.	*	*	*	*	*	*	*	*	*	*	*	*
000	629	PCY	*	0.	68.	*	*	*	*	*	*	*	*	*	*	*	*
000	627	PS	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	619	PTM	*	0.	274.	*	*	*	*	*	*	*	*	*	*	*	*
000	616	POV	*	0.	29.	*	*	*	*	*	*	*	*	*	*	*	*
000	603	OCP	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	587	OCTR	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	586	OTR	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	582	NFD	*	0.	103.	*	*	*	*	*	*	*	*	*	*	*	*
000	577	NSS	*	0.	172.	*	*	*	*	*	*	*	*	*	*	*	*
000	561	*	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	560	*	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	554	NB	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	553	NLG	*	0.	67.	*	*	*	*	*	*	*	*	*	*	*	*
000	552	MH	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	551	NS	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	549	NPB	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	548	MCSA	*	0.	7.	*	*	*	*	*	*	*	*	*	*	*	*
000	547	*	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	546	NYSW	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	542	NYD	*	0.	71.	*	*	*	*	*	*	*	*	*	*	*	*
000	537	NEZP	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	534	NLC	*	0.	6.	*	*	*	*	*	*	*	*	*	*	*	*
000	530	NN	*	0.	65.	*	*	*	*	*	*	*	*	*	*	*	*
000	525	NAP	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	524	*	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	523	METW	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	515	MI	*	0.	107.	*	*	*	*	*	*	*	*	*	*	*	*
000	513	IAT	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	511	ME	*	0.	35.	*	*	*	*	*	*	*	*	*	*	*	*
000	510	MDW	*	0.	84.	*	*	*	*	*	*	*	*	*	*	*	*
000	509	MB	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	507	MOV	*	0.	7.	*	*	*	*	*	*	*	*	*	*	*	*
000	506	MSE	*	0.	70.	*	*	*	*	*	*	*	*	*	*	*	*
000	502	MISS	*	0.	20.	*	*	*	*	*	*	*	*	*	*	*	*
000	500	MTR	*	0.	102.	*	*	*	*	*	*	*	*	*	*	*	*
000	498	MCRR	*	0.	424.	*	*	*	*	*	*	*	*	*	*	*	*
000	497	MGA	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	493	*	*	0.	6.	*	*	*	*	*	*	*	*	*	*	*	*
000	484	MTFR	*	0.	113.	*	*	*	*	*	*	*	*	*	*	*	*
000	480	MNS	*	0.	151.	*	*	*	*	*	*	*	*	*	*	*	*
000	475	MNJ	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	471	MSTR	*	0.	9.	*	*	*	*	*	*	*	*	*	*	*	*
000	466	MCR	*	0.	69.	*	*	*	*	*	*	*	*	*	*	*	*

1	2	3	4			5			6			7			8		
			(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
000	462	*	*	0.	75.	*	*	*	*	*	*	*	*	*	*	*	*
000	460	MRS	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	459	MJ	*	0.	13.	*	*	*	*	*	*	*	*	*	*	*	*
000	453	*	*	0.	8.	*	*	*	*	*	*	*	*	*	*	*	*
000	451	LW	*	0.	3.	*	*	*	*	*	*	*	*	*	*	*	*
000	450	LPN	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	447	LBR	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	446	LNAC	*	0.	10.	*	*	*	*	*	*	*	*	*	*	*	*
000	445	ISO	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	443	LPB	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	442	INW	*	0.	54.	*	*	*	*	*	*	*	*	*	*	*	*
000	441	LA	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	430	LUN	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	428	LAJ	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	427	LRS	*	0.	23.	*	*	*	*	*	*	*	*	*	*	*	*
000	426	LC	*	0.	26.	*	*	*	*	*	*	*	*	*	*	*	*
000	425	LSI	*	0.	302.	*	*	*	*	*	*	*	*	*	*	*	*
000	424	LEPW	*	0.	4.	*	*	*	*	*	*	*	*	*	*	*	*
000	423	LEF	*	0.	25.	*	*	*	*	*	*	*	*	*	*	*	*
000	420	LSBC	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	417	LSTT	*	0.	53.	*	*	*	*	*	*	*	*	*	*	*	*
000	407	LDRT	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	404	LT	*	0.	400.	*	*	*	*	*	*	*	*	*	*	*	*
000	403	KENN	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	402	KIT	*	0.	512.	*	*	*	*	*	*	*	*	*	*	*	*
000	401	KCI	*	0.	326.	*	*	*	*	*	*	*	*	*	*	*	*
000	398	LAL	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	366	HPTD	*	0.	21.	*	*	*	*	*	*	*	*	*	*	*	*
000	359	*	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	357	IHB	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	352	*	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	341	*	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	340	*	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	337	*	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	334	HRT	*	0.	8.	*	*	*	*	*	*	*	*	*	*	*	*
000	331	HSW	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	329	HBS	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	328	HE	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	324	*	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	323	GU	*	0.	9.	*	*	*	*	*	*	*	*	*	*	*	*
000	321	GJ	*	0.	9.	*	*	*	*	*	*	*	*	*	*	*	*
000	320	GNWR	*	0.	69.	*	*	*	*	*	*	*	*	*	*	*	*
000	319	GWIN	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	314	GMRC	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	312	GBW	*	0.	367.	*	*	*	*	*	*	*	*	*	*	*	*
000	311	GWR	*	0.	49.	*	*	*	*	*	*	*	*	*	*	*	*
000	307	GNA	*	0.	21.	*	*	*	*	*	*	*	*	*	*	*	*
000	302	GRR	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	300	GSF	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	298	GANO	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*

1	2	3	4			5			6			7			8		
			(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
000	293	GHH	*	0.	60.	*	*	*	*	*	*	*	*	*	*	*	*
000	290	GM	*	0.	16.	*	*	*	*	*	*	*	*	*	*	*	*
000	287	GCW	*	0.	5.	*	*	*	*	*	*	*	*	*	*	*	*
000	282	FOR	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	277	FWB	*	0.	8.	*	*	*	*	*	*	*	*	*	*	*	*
000	273	FRDN	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	265	FP	*	0.	2.	*	*	*	*	*	*	*	*	*	*	*	*
000	264	FJG	*	0.	10.	*	*	*	*	*	*	*	*	*	*	*	*
000	260	FPE	*	0.	54.	*	*	*	*	*	*	*	*	*	*	*	*
000	248	*	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	247	EDW	*	0.	20.	*	*	*	*	*	*	*	*	*	*	*	*
000	245	EJR	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	242	EACH	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	241	ELS	*	0.	28.	*	*	*	*	*	*	*	*	*	*	*	*
000	234	ETWN	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	222	CIRR	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
000	220	DMN	*	0.	13.	*	*	*	*	*	*	*	*	*	*	*	*
000	219	DT	*	0.	189.	*	*	*	*	*	*	*	*	*	*	*	*
000	217	DS	*	0.	43.	*	*	*	*	*	*	*	*	*	*	*	*
000	215	CBL	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
011	208	DTI	3.7	1224.	0.	0.3	0.1	0.	0.5	0.6	0.	2.7	1.1	0.	3.9	5.5	0.
011	238	EJE	10.8	940.	3051.	0.1	0.1	1.	0.2	0.3	7.	1.1	0.4	10.	1.6	2.3	52.
011	240	EL	3.0	9562.	10874.	0.1	0.0	3.	0.1	0.1	13.	2.4	1.0	92.	2.9	4.1	395.
011	308	GTW	4.6	3333.	4094.	0.1	0.0	1.	0.1	0.2	6.	1.9	0.7	24.	2.6	3.6	117.
011	354	ITC	3.9	574.	561.	0.2	0.1	0.	0.3	0.4	2.	3.9	1.5	7.	5.5	7.8	35.
011	364	IRN	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
011	413	LNE	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
011	419	LWV	*	0.	9.	*	*	*	*	*	*	*	*	*	*	*	*
011	429	LHR	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
011	436	LI	453.0	29.	6732.	0.1	0.0	3.	0.0	0.1	8.	0.3	0.1	15.	0.2	0.3	34.
011	431	LV	1.9	3603.	2645.	0.2	0.1	2.	0.3	0.4	8.	4.2	1.6	37.	5.5	7.8	174.
011	456	MEC	4.5	821.	1222.	0.1	0.0	1.	0.1	0.2	2.	1.8	0.7	8.	2.1	3.0	33.
011	550	NW	2.3	48648.	24557.	0.1	0.0	4.	0.1	0.1	21.	1.6	0.6	107.	2.8	3.9	654.
011	626	PLE	4.2	1347.	0.	0.2	0.1	0.	0.2	0.3	0.	2.1	0.8	0.	2.3	3.2	0.
011	623	RDG	4.4	3136.	5756.	0.1	0.0	3.	0.1	0.2	10.	1.9	0.7	39.	2.1	2.9	156.
011	622	PC	2.8	78115.	79503.	0.1	0.0	21.	0.1	0.1	88.	2.0	0.8	546.	2.4	3.3	2331.
011	663	RFP	3.0	1033.	1040.	0.3	0.1	1.	0.6	0.9	5.	2.2	0.9	5.	5.4	7.6	47.
011	839	WM	2.8	2575.	1336.	0.2	0.1	1.	0.3	0.4	4.	2.2	0.9	9.	3.3	4.6	46.
011	105	CP	2.3	50042.	0.	0.0	0.0	0.	0.0	0.0	0.	0.0	0.0	0.	0.0	0.0	0.
011	120	CV	4.3	270.	411.	0.4	0.2	1.	0.4	0.6	2.	4.8	1.9	7.	5.4	7.7	30.
011	119	CNJ	7.8	599.	0.	0.1	0.0	0.	0.1	0.1	0.	2.0	0.8	0.	2.3	3.2	0.
011	125	CO	2.4	26227.	18690.	0.1	0.0	4.	0.1	0.1	19.	1.8	0.7	101.	2.6	3.7	529.
011	129	CEI	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
011	143	CRI	*	0.	228.	*	*	*	*	*	*	*	*	*	*	*	*
011	195	DH	2.2	3482.	2138.	0.2	0.1	1.	0.2	0.3	6.	3.0	1.2	21.	3.7	5.2	96.
011	205	DTS	5.4	228.	276.	0.5	0.2	0.	0.8	1.1	2.	2.5	1.0	2.	3.9	5.5	11.
011	27	PRSL	*	0.	0.	*	*	*	*	*	*	*	*	*	*	*	*
011	50	BO	2.7	24941.	16164.	0.1	0.0	4.	0.1	0.2	21.	2.3	0.9	110.	3.6	5.0	602.
011	59	BCK	*	0.	95700.	*	*	*	*	*	*	*	*	*	*	*	*
011	56	BAR	3.9	508.	702.	0.2	0.1	1.	0.3	0.4	2.	3.3	1.3	9.	3.6	5.1	34.

1	2	3	4 (a)	4 (b)	4 (c)	5 (a)	5 (b)	5 (c)	6 (a)	6 (b)	6 (c)	7 (a)	7 (b)	7 (c)	8 (a)	8 (b)	8 (c)
011	61	BLE	3.6	2223.	1482.	0.1	0.1	1.	0.2	0.3	3.	1.2	0.5	5.	1.7	2.4	26.
011	69	BM	4.1	2466.	3061.	0.2	0.1	2.	0.2	0.3	8.	2.5	1.0	25.	3.0	4.3	112.
012	712	SCL	2.3	31720.	19342.	0.1	0.0	4.	0.1	0.1	21.	1.8	0.7	104.	2.7	3.8	549.
012	724	SOU	3.7	27987.	20830.	0.1	0.0	3.	0.1	0.1	17.	1.0	0.4	61.	1.6	2.2	331.
012	444	LN	1.7	39169.	15209.	0.1	0.0	3.	0.1	0.1	14.	1.4	0.5	63.	1.9	2.7	317.
012	350	ICG	2.1	28874.	18610.	0.1	0.0	4.	0.1	0.1	20.	2.0	0.8	115.	2.7	3.8	562.
012	263	FEC	2.8	1923.	997.	0.2	0.1	1.	0.3	0.5	3.	1.6	0.6	5.	2.3	3.3	24.
012	299	GA	2.0	769.	460.	0.3	0.1	0.	0.4	0.6	2.	2.1	0.8	3.	2.9	4.1	15.
013	268	PWD	1.8	2302.	991.	0.3	0.1	1.	0.4	0.6	4.	2.5	1.0	7.	3.6	5.1	38.
013	213	DMIR	3.3	2093.	1708.	0.2	0.1	1.	0.2	0.3	4.	1.3	0.5	7.	1.7	2.4	32.
013	216	DWP	2.0	1179.	422.	0.2	0.1	0.	1.9	2.7	2.	0.5	0.2	0.	1.9	2.7	2.
013	400	KCS	2.1	6877.	3110.	0.1	0.0	1.	0.1	0.2	5.	1.4	0.6	13.	2.0	2.8	68.
013	482	SOO	2.0	9396.	4472.	0.1	0.0	1.	0.2	0.2	7.	2.4	0.9	29.	4.2	5.9	183.
013	559	NWP	3.0	469.	0.	0.3	0.1	0.	0.4	0.5	0.	2.2	0.8	0.	2.6	3.7	0.
013	490	MKT	2.1	4859.	2363.	0.2	0.1	1.	0.2	0.3	5.	2.7	1.1	20.	3.8	5.3	99.
013	494	MP	2.1	37030.	19370.	0.1	0.0	3.	0.1	0.1	16.	1.2	0.5	66.	1.8	2.6	363.
013	721	SP	2.2	63653.	47309.	0.0	0.0	7.	0.1	0.1	33.	0.8	0.3	116.	1.1	1.5	558.
013	693	SLSF	2.2	14564.	8359.	0.1	0.0	2.	0.1	0.2	11.	1.6	0.6	39.	2.3	3.2	203.
013	694	SSW	2.1	9312.	3705.	0.1	0.0	1.	0.1	0.2	5.	1.2	0.4	13.	1.6	2.2	64.
013	762	TM	5.3	154.	295.	0.5	0.2	0.	0.6	0.9	2.	4.9	1.9	5.	6.8	9.6	23.
013	769	TPW	3.0	688.	420.	0.2	0.1	0.	0.3	0.5	1.	1.6	0.6	2.	2.4	3.4	10.
013	802	UP	2.1	56528.	25103.	0.0	0.0	3.	0.1	0.1	15.	0.8	0.3	57.	1.1	1.5	291.
013	840	WP	2.2	4999.	2800.	0.1	0.0	1.	0.1	0.2	5.	1.2	0.5	12.	1.5	2.2	51.
013	22	ATSF	2.2	52223.	31319.	0.0	0.0	5.	0.1	0.1	21.	1.1	0.4	115.	1.5	2.1	528.
013	197	DRGW	1.9	8745.	3481.	0.1	0.0	1.	0.1	0.2	5.	0.8	0.3	8.	1.2	1.7	43.
013	145	RI	2.4	14350.	8516.	0.1	0.0	3.	0.1	0.2	12.	2.2	0.9	60.	2.9	4.1	285.
013	131	CNW	2.3	22969.	13233.	0.1	0.0	3.	0.1	0.1	16.	2.8	1.1	114.	3.8	5.4	570.
013	140	MILW	2.4	19140.	11876.	0.1	0.0	4.	0.1	0.1	15.	2.4	0.9	112.	2.4	3.4	407.
013	157	CS	2.2	2072.	552.	0.3	0.1	0.	0.3	0.5	2.	1.6	0.6	3.	2.1	3.0	13.
013	76	BN	1.8	84739.	44269.	0.1	0.0	9.	0.1	0.1	39.	1.5	0.6	216.	2.0	2.8	1015.

APPENDIX H

DERIVATIONS OF THE GENERALIZED MICRO-ECONOMIC MODEL

APPENDIX H

APPLICATION OF A MICROECONOMIC MODELING TECHNIQUE* TO ESTIMATE PRICE INCREASE RESULTING FROM COMPLIANCE WITH POTENTIAL NOISE STANDARDS BY RAIL CARRIERS

Objective of the Model.

The effect of a noise emission standard on the railroad industry is to impose variable financial and economic impacts on firms in the industry. The impact varies from firm to firm since it represents the cost to comply with a noise abatement regulation on railroad property owned and operated by individual firms. To cover the compliance cost imposed by such a regulation, individual railroad firms have but one option to recover such costs directly, assuming they do not abosrb the costs through profits and that no Federal subsidy is available. This option is to petition the ICC for a freight rate change which can be expressed as a unit price increase for the commodities the firms transports by rail. The objective of the microeconomic price model is to analyze the size and relative effect of a price increase on each railroad firm which must comply with a noise emission regulation. The model analyzes only the compliance impacts of the imposition of the noise standard and appropriately excludes from consideration the normal dynamics of the industry and transportation markets.

Assumptions

To model the effect of a price increase, the following assumptions are made:

1) The changes in price and demand are small, so that a constant price elasticity of demand can be used to relate these changes:

$$\epsilon_d \frac{\Delta p}{p} = - \frac{\Delta q}{q} \qquad (1)$$

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* The microanalytical model concepts and derivation of the principal equations incorporated in this section are based directly on the models derived by E. J. Battison, Senior Economist, Energy & Environmental Sciences Group, Science Applications, Inc. (currently associated with NUS Corporation, Gaithersburg, MD.)

where ε_d is the price elasticity of demand,

Δp is the increase in the average freight revenue per ton-mile,

Δq is the decrease in revenue ton-miles of services demanded.

2) Constant returns to scale are valid for the levels of service provided, so that the unit cost of providing services is contant; and

3) The net income remains the same after the railroad firm or operator has complied with the noise emission standard.

Figure H-1 depicts the generalized relationship between the variables of price and demand before and after imposition of a noise regulation.

It should be noted that these assumptions can be relaxed or modified if sufficient data or information are available to indicate (a) how production costs vary with production levels and (b) which potential pricing policy is likely to be adopted and applied by the railroad industry.

Input Data Requirement

With the above assumptions, the input data required to calculate the price increase for each railroad are:

- The price elasticity of demand, ε_d,
- The average freight revenue per ton-mile before regulation, p,
- The average operating cost per ton-mile, c,
- The total compliance cost, CC.

For Class I railroads, the unit revenue ton-mile, p, and the unit cost or expense per ton-mile, c, are readily available in documents published by the AAR, ICC, and Moody's. The same information is available for some Class II railroads. No reliable data on price elasticity of

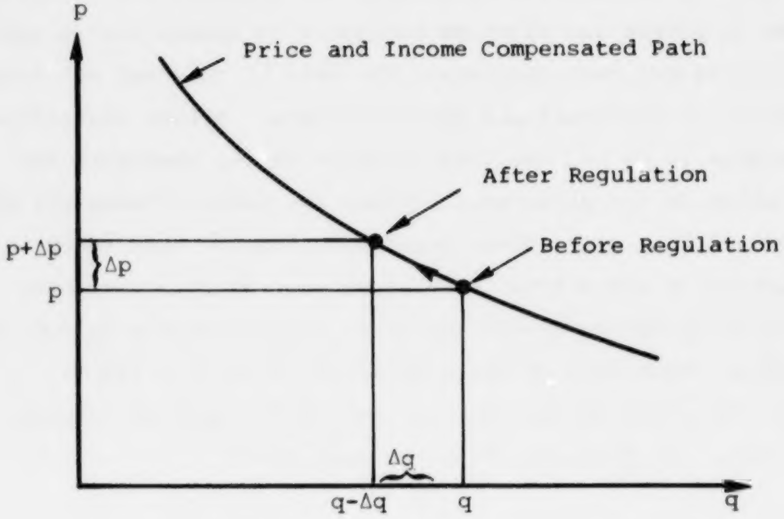

FIGURE H-1: PRICE-DEMAND RELATIONSHIP

demand are available at the level of individual rail carriers as reported previously in another section of this report; however, two values of price elasticity of demand, specifically, $\epsilon_d = -0.39$ and $\epsilon_d = -1.41$, have been used to represent the range of elasticities for the entire industry.

The Price Model

The model uses comparative statics as the approach for estimating the increases in prices and revenues necessary to comply with a noise standard by individual rail carriers. The case of constant net income after regulation is discussed and explained here. Before regulation, the total revenue is pq and the total expense is cq, therefore the net income, which is the difference between the total revenue and the total expense, is $(p - c)q$. After regulation, assume that there is a price increase of Δp and a total compliance cost of CC. The total gross revenue is $(p+\Delta p)(q-\Delta q)$ and the total expense is $c(q-\Delta q)+CC$, since the demand after imposition of the regulation is $(p+\Delta p-c)(q-\Delta q)$. Assuming that the railroad operator can retain the same net income after regulation, the following equation must hold:

$$\begin{matrix}\text{Net Income} \\ \text{After Regulation}\end{matrix} - \begin{matrix}\text{Net Income} \\ \text{Before Regulation}\end{matrix} = 0 \qquad (2)$$

i.e., $(p+\Delta p-c)(q-\Delta q)-CC - (p-c)q = 0$

Using the elasticity relationship (1), this equation can be simplified to:

$$\epsilon_d \, (\Delta p)^2 + \left[\epsilon_d(p-c)+p\right] (\Delta p) - \frac{CC}{q}\, p = 0 \qquad (3)$$

Referring to Figure H-2, the net income before regulation is represented by the shaded area KLPB and the net income after regulation is represented by the shaded are FGHA. The increase in net income, $(p-c)\Delta q$, is represented by the shaded area MNPB. Therefore, equations (2) and (3) are equivalent to equating the areas:

$$\text{Area FGHA} - \text{Area KLPB} - 0 \qquad (4)$$

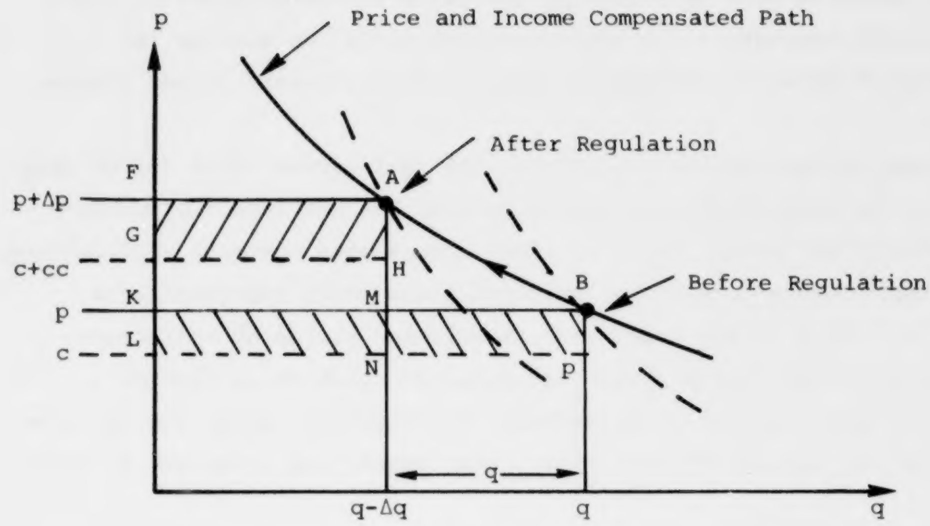

FIGURE H-2: NET INCOME BEFORE AND AFTER REGULATION

Equation (3) is a quadratic equation of the price increases, Δp. The coefficients of this equation are known since ε_d, p, c, CC, q are known. The equation can therefore be solved for Δp. The model solutions yield estimates of the price increases that the railroad operator would need to impose in order to cover the compliance costs.

Solutions of equation (3) may have two positive roots. The smaller positive root is chosen as the price increase solution, since it logically represents the price increase needed to achieve the objective of covering compliance costs with an increase in net income.

Under certain market conditions, the rail carrier will not be able to cover the compliance cost and to recover his net income along with $(p-c)\Delta q$ with any price increase. This occurs when the data representing a railroad's operations (e.g., unit price and costs and compliance costs) are input to the model and its solution yields no real roots. In such instances, price/profit maximization solution is obtained, since it represents the price increase solution that gives the operator the least net income deficit, (i.e., some compliance costs are covered).

The Employment Model

When a rail carrier increases the price of service, if the price elasticity of demand is less than zero, demand and output will decrease. The employment level may also drop, depending on the value of the elasticity and the nature of the change in service which caused the price increase. The price change and demand change are related by the elasticity identity shown in (1):

$$\varepsilon_d \frac{\Delta p}{p} = - \frac{\Delta q}{q}$$

i.e. $$\Delta q = -\varepsilon_d q \frac{\Delta p}{p}$$

If employment is directly proportional to adjusted revenue (i.e., revenue less compliance cost), the decrease in employment, E, is related to the decrease in adjusted revenue by:

$$\Delta E = \beta \quad (p+\Delta p)(q-\Delta q) - pq - CC$$

where β is the marginal labor/adjusted revenue coefficient. For this relationship, the employment decrease caused by the price increase is given by:

$$\Delta E = \beta q \quad \varepsilon_d \frac{(\Delta p)^2}{p} + \Delta p(1+\varepsilon_d) - \frac{CC}{q}$$

where $E = pq$

The estimates of employment changes presented in the analysis are based on the above model and its assumption. This relationship assumes a constant coefficient β between employment and adjusted revenue. However, railroad employees may be kept on staff if the relationship between employment and revenue level becomes stronger (i.e., β becomes larger).

To elaborate, it should be further noted that employment may increase under particular conditions that could easily occur.

1. When demand for a good or service is price inelastic, (i.e., $0 > \varepsilon_d > -1.00$), total revenue increases when price increases. If additional labor inputs are associated with the price increases, an increase in employment may accompany the rise in price.
2. Noise regulation could effect a change in railroad services, and the labor/adjusted revenue mix may increase. This is likely to occur for the more stringent regulations, L_{dn} 65 and L_{dn} 60, when a change in operations is necessary to meet these regulations.

The decreases in employment estimated here do not consider either of these possibilities. Moreover, the increase in employment caused directly by compliance activities is not calculated.

The Analytical Derivation of the Generalized Microeconomic Model* To Forecast Price Increases Resulting From Compliance With Noise Standards.

Derivation of Basic Equations

Let p be the unit price before regulation and $p + \Delta p$ be the unit price after regulation. Hence Δp is the price increase after regulation. Let q be the output (production) level before regulation and $q - \Delta q$ be the output level after regulation. Hence, Δq is the decrease in output level after regulation.

Assuming that they are small, Δp and Δq are related by:

$$\epsilon_d \frac{\Delta p}{p} = - \frac{\Delta q}{q} \tag{1}$$

where ϵ_d is the price elasticity of demand.

Assuming that the unit cost of production, c, is a function of production (i.e., output) level q, then let the function $c\{q\}$ be the unit cost of production before regulation and let the function $c\{q - \Delta q\}$ be the unit cost of production after regulation.

The total revenue before regulation is pq and the total costs are $c\{q\}q$. Therefore, the total net income Y_b before regulation is:

$$Y_b = [p - c\{q\}]q \tag{2}$$

Similarly, the total net income Y_a after regulation is:

$$Y_a = [p + \Delta p - c\{q - \Delta q\} - cc](q - \Delta q), \tag{3}$$

where cc is the unit compliance cost due to regulation.

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* The microanalytical model concepts and derivation of the principal equations incorporated in this section are based directly on the models derived by E.J. Battison, Senior Economist, Energy & Environmental Sciences Group, Science Applications, Inc.[13]

A rail carrier may pursue any policy to cover compliance costs and protect its market position after regulation. The following three policies are studied:

I. Constant Profit Margin. To maintain the same profit margin (i.e., net income per unit sale) before and after regulation.

II. Constant Net Income. To maintain the same net income before and after regulation.

III. Increased Net Income. To increase the net income by an amount $[\,p - c\{q\}]\,\Delta q$ after regulation.

Estimation of the price increases in the main text (Section 7) is based on the policy of increased net income.

I. Constant Profit Margin

To maintain the same profit margin, a rail carrier needs to set Δp such that

$$\frac{Y_B}{q} = \frac{Y_A}{q-\Delta q}$$

Using (2) and (3) the above equation becomes:

$$p - c\{q\} = p + \Delta p - c\{q - \Delta q\} - cc$$

i.e.,

$$\Delta p = cc + c\{q + \varepsilon_d q \frac{\Delta p}{p}\} - c\{q\} \qquad (5)$$

II. Constant Net Income

To maintain the same net income, a rail carrier needs to set Δp such that:

$$Y_B = Y_A \tag{6}$$

Using (2) and (3), the above equation becomes:

$$[p - c\{q\}]q = [p + \Delta p - c\{q - \Delta q\} - cc](q - \Delta q)$$

i.e. $$[\Delta p - cc - c\{q - \Delta q\} + c\{q\}]q - [p + \Delta p - c\{q - \Delta q\} - cc]\,\Delta q = 0$$

Using (1) and rearranging terms yields:

$$\varepsilon_d(\Delta p)^2 + [\varepsilon_d[p - cc - c\{q + \varepsilon_d q \frac{\Delta p}{p}\} + p](\Delta p)$$

$$-[cc + c\{q + \varepsilon_d q \frac{\Delta p}{p}\} - c\{q\}]p = 0 \tag{7}$$

III. Increased Net Income

To increase the net income by an amount $(p-c)\Delta q$ after regulation, a rail carrier needs to set Δp such that:

$$Y_B + [p - c\{q\}]\Delta q = Y_A \tag{8}$$

Using (2) and (3), above equation becomes

$$[p - c\{q\}]q + [p - c\{q\}]\Delta q = [p + \Delta p - c\{q - \Delta q\} - cc](q - \Delta q)$$

i.e., $$[\Delta p - c\{q - \Delta q\} + c\{q\} - cc]q - [2p + \Delta p - c\{q - \Delta q\} - c\{q\} - cc]\Delta q = 0$$

Using (1) and re-arranging terms yields:

$$\varepsilon_d(\Delta p)^2 + (\varepsilon_d[2p - c\{q + \varepsilon_d q \frac{\Delta p}{p}\} - c\{q\} - cc] + p)(\Delta p)$$

$$-[c\{q + \varepsilon_d q \frac{\Delta p}{p}\} - c\{q\} + cc]p = 0 \tag{9}$$

Cost Function Approximations

Although equations (5), (7) and (9) can be solved in principle for any cost function $c\{q\}$ using an approximation to simplify the cost function can reveal a great deal about the qualitative behavior of Δp under different market conditions. A first order approximation of $c\{q\}$ can be obtained by using only the first order term in the Taylor series expansion about q:

$$c\{q - \Delta q\} = c\{q\} + \gamma \Delta q \qquad (10)$$

This approximation is good for sufficiently small changes in price and output. An increasing return to scale is associated with a positive γ and a diminishing return to scale is associated with a negative γ. Using the first order approximation (10), (5) becomes:

$$\Delta p = cc - \gamma \varepsilon_d q \frac{\Delta p}{p}$$

$$\Delta p = \frac{cc}{1 + \gamma \varepsilon_d \frac{q}{p}}$$

Using the first order approximation (10), (7) become:

$$\varepsilon_d (\Delta p)^2 + [\varepsilon_d [p - cc - c\{q\} + \gamma \varepsilon_d \frac{q}{p} \Delta p] + p] (\Delta p) - [cc - \gamma \varepsilon_d \frac{q}{p} \Delta p] p = 0$$

i.e., $\varepsilon_d (1 + \gamma \varepsilon_d \frac{q}{p} \Delta p)(\Delta p)^2 + [\varepsilon_d [p - cc - c\{q\} + \gamma q] + p] (\Delta p) - (cc) p = 0$ (12)

Using the first order approximation (10), (9) become:

$$\varepsilon_d(\Delta p)^2 + [\varepsilon_d[2p - 2c\{q\} + \gamma\varepsilon_d \frac{q}{p}\Delta p - cc] + p](\Delta p) - [cc - \gamma\varepsilon_d \frac{q}{p}\Delta p]p = 0$$

i.e. $$[\varepsilon_d(1 + \gamma\varepsilon_d \frac{q}{p})](\Delta p)^2 + [\varepsilon_d[2p - 2c\{q\} - cc + \gamma q] + p](\Delta p) - (cc)p = 0 \qquad (13)$$

Assuming that the return to scale is constant, then $\gamma = 0$ and

$$c\{q - \Delta q\} = c\{q\} = c \qquad (14)$$

Therefore, with the constant returns to scale cost function, the price increase for the constant profit margin policy is:

$$\Delta p = cc \qquad (15)$$

The price increase for the constant net income policy is given by roots to the equation:

$$\varepsilon_d(\Delta p)^2 + (\varepsilon_d\ [p-cc-c] + p)(\Delta p) - (cc)\ p = 0 \qquad (16)$$

The price increase for the increased net income policy is given by the roots to the equation:

$$\epsilon_d(\Delta p)^2 + (\epsilon_d\ [2p-2c-cc] + p)(\Delta p) - (cc)\ p = 0 \qquad (17)$$

This is the model used in the main text (Section 7) to estimate price increases after regulation.

Existence of Real Solutions for the Increased Net Income Case with Constant Cost

The price increase for the increased net income case with constant cost is given by the roots to equation (17):

$$\varepsilon_d(\Delta p)^2 + (\varepsilon_d[2(p-c) - cc] + p)(\Delta p) - (cc)\cdot p = 0.$$

The roots are:

$$\Delta p = \frac{-B \pm \sqrt{(B^2 - 4AC)}}{2A}$$

where $A = \varepsilon_d$

$B = \varepsilon_d[2(p-c) - cc] + p$

$C = -(cc)\cdot p$

Real roots exist if and only if $B^2 - 4AC \geq 0$.

Since $4AC = -4\varepsilon_d\, ccp > 0$,the real roots, if exist, are both positive (if $B>0$) or both negative (if $B<0$).

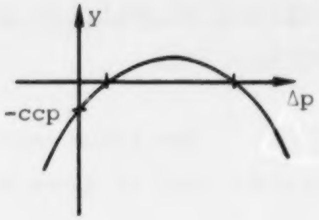
Let $y(\Delta p)$ be a quadratic function of Δp such that

$$y(\Delta p) = \varepsilon_d(\Delta p)^2 + (\varepsilon_d[2(p-c) - cc] + p] + p)(\Delta p) - (cc)\cdot p$$

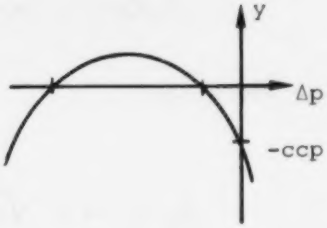
i.e. $y(\Delta p) = A(\Delta p)^2 + B(\Delta p) + C$

Since $C = -(cc).p < 0$, four cases may occur:

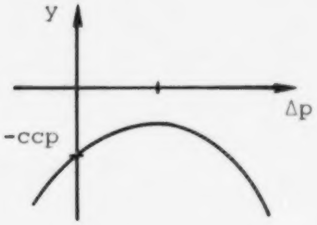
i) $B^2 - 4AC \geq 0$, $B > 0$.
Two real positive roots exist.



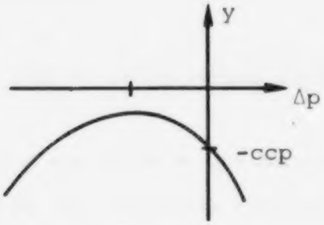
ii) $B^2 - 4AC \geq 0$, $B < 0$.
Two real negative roots exist.



iii) $B^2 - 4AC \leq 0$, $B > 0$.
No real root exists.
Adjusted profit maximization gives positive solution.



iv) $B^2 - 4AC \leq 0$, $B < 0$.
No real root exists.
Adjusted profit maximization gives negative solution.



Under normal economic market conditions, only cases i and iii would be considered.

The condition B>0 is satisfied if and only if

$$\epsilon_d\,[2(p-c)-cc] + p > o.$$

i.e., $$\frac{p}{-\epsilon_d} + cc > 2(p - c)$$

If ϵ_d is in the order of 1 and p-c is of a lower order of magnitude, then the above condition holds and B>0. Thus, the real roots, if they exist, are positive, and the adjusted profit maximization solution has a positive solution. This is almost always the case with the levels of ϵ_d values, compliance costs, and price increases postulated for regulatory impact analysis.

APPENDIX I

ECONOMIC IMPACTS BY RAILROAD COMPANIES

Contained in this appendix is a computer printout of 5 financial ratios that were described previously in Section 7. The results of each ratio calculated are displayed as decimals in groups of three, based upon (a) no regulation, (b) estimated noise abatement procedural costs to comply with an L_{dn} 70 regulatory study level and (c) estimated noise abatement procedural costs to comply with an L_{dn} 65 regulatory study level. For example, the ratio net operating revenue divided by gross revenues for a given railroad company has 3 results displayed in a row; these are followed in the same row by the remaining ratios in groups of three.

Preceding the ratio data, information is provided to indicate the class and region associated with the listing by ACI and uniform alpha code designation of each railroad company analyzed. The legend for road class is as follows:

00 = class II
01 = class 1.

The legend for region is as follows:

0 = not specified
1 = Eastern
2 = Southern
3 = Western

When a 99.00 is displayed in the printout, this means that the data were not available from the data sources used in this study such as the ICC's 'R' reports and Moody's Transportation Manual.

Legend

1 Class

2 Region

3 ACI Code

4 Uniform Alpha Code

5 Net Operating Revenue
Gross Revenue

(a)	(b)	(c)
No Reg.	70dB	65dB

6 Net Operating Revenue
Total Assets

(a)	(b)	(c)
No Reg.	70dB	65dB

7 Gross Revenue - Total Assets

(a)	(b)	(c)
No Reg.	70dB	65dB

8 Current Assets - Current Liabilities

(a)	(b)	(c)
No. Reg.	70dB	65dB

9 Current Assets - Total Assets

(a)	(b)	(c)
No Reg.	70dB	65dB

1	2	3	4	5 (a)	5 (b)	5 (c)	6 (a)	6 (b)	6 (c)	7 (a)	7 (b)	7 (c)	8 (a)	8 (b)	8 (c)	9 (a)	9 (b)	9 (c)
00	0	13	AHA	-0.12	-0.15	-0.51	-0.08	-0.10	-0.19	0.71	0.68	0.37	5.08	3.62	0.88	0.30	0.29	0.15
00	0	12	AN	0.37	0.37	0.35	0.12	0.12	0.11	0.32	0.31	0.31	1.77	1.76	1.68	0.23	0.23	0.22
00	0	11	APA	0.51	0.50	0.48	0.41	0.41	0.37	0.82	0.82	0.77	0.47	0.46	0.44	0.14	0.14	0.13
00	0	10	AA	-0.25	-0.25	-0.30	-0.09	-0.09	-0.11	0.38	0.38	0.37	0.97	0.96	0.83	0.11	0.11	0.11
00	0	9	AB	0.18	0.18	0.17	0.08	0.08	0.08	0.45	0.45	0.45	1.64	1.62	1.60	0.31	0.31	0.31
00	0	4	AWW	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	3	ACY	0.10	0.09	0.04	0.04	0.04	0.02	0.41	0.41	0.39	0.84	0.83	0.75	0.14	0.14	0.14
00	0	2	AIB	-0.62	-0.63	-0.86	-0.15	-0.15	-0.17	0.24	0.24	0.20	0.67	0.66	0.48	0.10	0.10	0.08
00	0	49	AHC	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	42	ASAB	0.39	0.39	0.34	0.21	0.21	0.17	0.53	0.53	0.50	1.13	1.12	1.00	0.24	0.24	0.23
00	0	38	AVL	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	35	ANP	0.19	0.15	-0.35	0.01	0.00	-0.01	0.03	0.03	0.03	1.22	1.21	1.11	0.19	0.19	0.18
00	0	32	AIS	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	31	AEC	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	23	AWP	0.23	0.23	0.22	0.15	0.14	0.14	0.64	0.63	0.63	1.19	1.17	1.14	0.21	0.20	0.20
00	0	21	ADN	0.53	0.53	0.52	0.42	0.42	0.40	0.80	0.80	0.77	1.10	1.10	1.08	0.56	0.56	0.55
00	0	20	AMH	0.46	0.46	0.44	0.36	0.35	0.34	0.78	0.77	0.77	1.12	1.09	1.05	0.30	0.30	0.30
00	0	19	AHC	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	18	AICS	0.15	0.15	0.14	0.23	0.23	0.22	1.56	1.55	1.53	1.64	1.64	1.59	0.34	0.34	0.33
00	0	16	ALM	0.38	0.38	0.35	0.28	0.28	0.24	0.74	0.73	0.69	2.85	2.80	2.39	0.30	0.30	0.28
00	0	14	ABL	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	196	DC	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	193	DVS	0.0	-0.04	-0.11	0.0	-0.03	-0.08	0.82	0.77	0.77	1.07	0.98	0.96	0.39	0.36	0.36
00	0	192	DHI	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	1.20	1.19	1.04	0.14	0.14	0.13
00	0	191	DR	0.55	0.55	0.54	1.23	1.18	1.16	2.22	2.16	2.16	0.79	0.75	0.69	0.18	0.17	0.17
00	0	188	CICO	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	186	CUVA	0.16	0.15	0.15	0.23	0.23	0.21	1.47	1.47	1.43	1.44	1.43	1.39	0.39	0.39	0.38
00	0	181	CIIF	0.17	0.12	0.05	0.09	0.06	0.02	0.52	0.49	0.49	6.44	4.56	3.04	0.36	0.34	0.34
00	0	179	CHW	0.46	0.46	0.45	0.21	0.21	0.21	0.46	0.46	0.46	1.19	1.16	1.12	0.09	0.09	0.09
00	0	177	CAGY	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	169	CIE	-0.22	-0.27	-0.82	-0.06	-0.07	-0.14	0.26	0.25	0.17	4.29	3.34	0.98	0.20	0.19	0.13
00	0	168	CSS	0.34	0.33	0.33	0.18	0.18	0.18	0.54	0.54	0.54	2.19	2.19	2.18	0.36	0.36	0.36
00	0	166	CCP	0.28	0.27	0.21	0.14	0.14	0.10	0.52	0.52	0.47	2.82	2.70	1.83	0.18	0.17	0.16
00	0	165	*	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	163	CIC	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	158	CW	0.40	0.40	0.39	0.19	0.19	0.18	0.47	0.47	0.46	1.19	1.13	1.15	0.25	0.24	0.24
00	0	153	CNTP	0.41	0.40	0.40	0.24	0.24	0.24	0.59	0.59	0.59	1.71	1.70	1.69	0.15	0.15	0.15
00	0	150	CIW	-0.63	-0.63	-0.68	-0.03	-0.03	-0.04	0.05	0.05	0.05	1.74	1.74	1.71	0.30	0.30	0.29
00	0	147	CSL	0.41	0.41	0.38	0.28	0.28	0.24	0.69	0.69	0.64	3.24	3.20	2.84	0.54	0.53	0.50
00	0	141	CPIT	-0.26	-0.30	-0.41	-0.10	-0.11	-0.15	0.38	0.37	0.37	0.43	0.43	0.43	16.46	16.02	16.02
00	0	139	CHTT	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	130	CIM	0.12	0.12	0.09	0.05	0.05	0.04	0.44	0.44	0.43	1.86	1.85	1.70	0.29	0.29	0.29
00	0	124	CHV	0.38	0.37	0.26	0.16	0.15	0.09	0.41	0.41	0.36	4.49	4.32	3.11	0.51	0.51	0.44
00	0	118	CGA	0.26	0.26	0.25	0.10	0.10	0.10	0.39	0.39	0.39	3.29	3.21	2.75	0.07	0.07	0.07
00	0	117	CHR	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	114	CACV	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	113	CABR	0.28	0.27	0.26	0.07	0.07	0.07	0.25	0.25	0.25	1.23	1.21	1.18	0.11	0.11	0.11
00	0	112	CCT	0.20	0.20	0.17	0.08	0.08	0.06	0.38	0.38	0.36	1.01	1.00	0.95	0.18	0.18	0.17
00	0	111	CIC	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	109	*	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	108	*	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	106	CBN	0.26	0.26	0.26	0.18	0.18	0.18	0.70	0.70	0.70	1.01	1.01	1.01	0.06	0.06	0.06
00	0	104	CBC	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00

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				5			6			7			8			9		
1	2	3	4	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
00	0	103	CN	0.05	0.05	0.05	0.03	0.03	0.03	0.49	0.49	0.49	1.04	1.04	1.04	0.13	0.13	0.13
00	0	101	CI	0.32	0.32	0.31	0.12	0.12	0.11	0.37	0.37	0.37	4.16	4.13	3.83	0.26	0.26	0.25
00	0	100	CWR	-0.25	-0.25	-0.32	-0.07	-0.08	-0.09	0.30	0.30	0.28	0.26	0.26	0.25	0.09	0.09	0.08
00	0	99	CF	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	97	CTN	0.30	0.30	0.28	0.25	0.25	0.22	0.83	0.83	0.79	1.54	1.53	1.44	0.34	0.34	0.32
00	0	92	CAD	0.22	0.17	0.10	0.16	0.12	0.07	0.75	0.70	0.70	0.36	0.35	0.32	0.25	0.24	0.24
00	0	91	BEDT	0.13	0.13	0.12	0.16	0.16	0.13	1.22	1.22	1.16	1.76	1.75	1.65	0.41	0.41	0.39
00	0	87	BMI	0.18	0.17	0.09	0.11	0.10	0.04	0.61	0.60	0.51	0.56	0.55	0.48	0.18	0.18	0.15
00	0	86	*	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	84	BXN	0.34	0.33	0.33	0.34	0.33	0.33	1.00	0.99	0.99	0.51	0.51	0.51	0.32	0.32	0.32
00	0	83	BRC	0.18	0.17	0.14	0.07	0.07	0.06	0.42	0.42	0.41	2.32	2.28	1.88	0.16	0.16	0.15
00	0	81	*	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	79	BH	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	76	BAF	0.30	0.29	0.22	0.18	0.18	0.13	0.60	0.60	0.57	1.61	1.59	1.25	0.25	0.25	0.24
00	0	65	BS	0.27	0.27	0.25	0.18	0.18	0.16	0.66	0.66	0.64	0.91	0.91	0.86	0.20	0.20	0.19
00	0	64	BCCT	0.24	0.24	0.21	0.12	0.12	0.10	0.49	0.49	0.48	1.42	1.41	1.08	0.08	0.08	0.07
00	0	877	YN	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	876	YAN	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	875	YS	0.01	-0.04	-0.33	0.00	-0.02	-0.12	0.48	0.44	0.36	-1.37	-1.15	-0.57	-0.16	-0.14	-0.12
00	0	873	YW	0.11	0.10	0.07	0.03	0.03	0.02	0.29	0.28	0.28	10.64	9.72	8.46	0.46	0.45	0.45
00	0	872	YVT	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	854	WSS	0.45	0.45	0.42	0.32	0.32	0.28	0.71	0.71	0.68	0.96	0.95	0.83	0.15	0.15	0.14
00	0	851	WNF	-1.05	-1.21	-1.50	-0.19	-0.21	-0.25	0.18	0.17	0.17	2.22	1.91	1.54	0.42	0.39	0.39
00	0	850	WW	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	848	WAG	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	846	WSYP	-0.52	-0.60	-0.73	-0.09	-0.10	-0.12	0.16	0.16	0.16	0.16	0.16	0.15	0.09	0.09	0.09
00	0	841	WA	0.25	0.25	0.23	0.16	0.16	0.15	0.65	0.64	0.64	1.72	1.68	1.53	0.20	0.20	0.19
00	0	838	WBRC	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	833	WYT	0.41	0.40	0.37	0.53	0.52	0.42	1.31	1.30	1.12	6.27	5.96	3.84	0.48	0.48	0.42
00	0	832	WSB	0.12	0.10	0.06	0.12	0.09	0.06	0.98	0.94	0.94	0.60	0.59	0.55	0.36	0.35	0.35
00	0	831	WIR	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	830	WYS	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	829	WCV	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	828	WS	-0.01	-0.09	-0.86	-0.01	-0.05	-0.20	0.63	0.57	0.23	1.98	1.81	0.93	0.94	0.85	0.34
00	0	826	WWV	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	817	VTR	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	815	VAMD	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	811	UTAH	0.02	0.01	0.01	0.01	0.01	0.00	0.38	0.38	0.38	4.94	4.87	4.65	0.30	0.29	0.29
00	0	809	UTR	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	808	UME	0.16	0.16	0.12	0.18	0.18	0.12	1.15	1.15	1.00	0.79	0.78	0.65	0.17	0.17	0.15
00	0	807	UT	-0.09	-0.09	-0.16	-0.04	-0.04	-0.07	0.48	0.48	0.43	0.11	0.10	0.08	0.01	0.01	0.01
00	0	803	UBR	0.24	0.24	0.22	0.20	0.20	0.18	0.85	0.85	0.82	1.58	1.57	1.43	0.26	0.26	0.25
00	0	799	SH	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	795	TN	0.46	0.46	0.46	0.15	0.15	0.15	0.32	0.32	0.32	13.38	18.29	17.39	0.79	0.79	0.78
00	0	794	SMA	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	793	SJL	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	788	TNM	0.39	0.38	0.38	0.22	0.22	0.21	0.56	0.56	0.56	2.11	2.07	1.99	0.10	0.10	0.10
00	0	785	TAW	-6.75	-7.21	-8.01	-0.15	-0.16	-0.17	0.02	0.02	0.02	2.00	1.64	1.26	0.09	0.09	0.09
00	0	784	TS	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	783	TCG	-0.02	-0.02	-0.03	-0.01	-0.01	-0.01	0.41	0.41	0.41	4.88	4.69	4.40	0.30	0.30	0.30
00	0	782	TCV	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	779	TRC	0.52	0.52	0.52	0.54	0.54	0.53	1.04	1.03	1.03	1.80	1.79	1.77	0.47	0.47	0.47

1	2	3	4	5			6			7			8			9		
				(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
00	0	771	TI	-0.03	-0.04	-0.11	-0.01	-0.01	-0.02	0.17	0.17	0.16	0.84	0.83	0.76	0.11	0.11	0.10
00	0	767	IENN	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	765	ISE	0.34	0.34	0.27	0.16	0.16	0.12	0.47	0.47	0.43	2.01	1.99	1.82	0.62	0.62	0.56
00	0	761	TCT	0.16	0.16	0.14	0.05	0.05	0.04	0.30	0.30	0.30	1.76	1.74	1.55	0.09	0.09	0.09
00	0	760	IP	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	759	IMEL	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	758	IASD	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	757	IBBA	0.19	0.19	0.17	0.12	0.12	0.11	0.67	0.67	0.65	0.55	0.55	0.51	0.08	0.08	0.06
00	0	755	IAG	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	750	IEXC	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	746	*	-0.25	-0.29	-0.35	-0.05	-0.06	-0.07	0.20	0.20	0.20	0.77	0.76	0.73	0.24	0.24	0.24
00	0	741	SPV	0.36	0.35	0.24	0.21	0.21	0.13	0.56	0.58	0.52	2.48	2.45	1.90	0.54	0.54	0.49
00	0	739	STE	0.46	0.46	0.46	1.16	1.15	0.54	2.41	2.39	2.05	0.32	0.32	0.30	0.19	0.18	0.16
00	0	730	*	0.19	0.19	0.07	0.04	0.04	0.01	0.22	0.22	0.21	0.51	0.50	0.31	0.02	0.02	0.02
00	0	727	SI	0.56	0.55	0.52	0.29	0.29	0.27	0.53	0.52	0.51	0.97	0.93	0.77	0.06	0.06	0.06
00	0	720	SIND	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	719	*	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	718	SEK	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	716	SEPA	0.16	0.18	0.17	0.05	0.05	0.04	0.26	0.26	0.26	0.87	0.85	0.83	0.10	0.10	0.10
00	0	709	ISU	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	707	SS	0.48	0.48	0.47	0.25	0.25	0.25	0.52	0.52	0.52	1.96	1.95	1.93	0.41	0.41	0.41
00	0	706	SSLV	0.41	0.30	-0.90	0.25	0.16	-0.15	0.60	0.53	0.17	2.89	2.27	0.69	0.71	0.62	0.20
00	0	705	SIAW	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	702	SDAE	0.17	0.17	0.16	0.03	0.03	0.03	0.19	0.19	0.19	0.59	0.59	0.58	0.06	0.06	0.06
00	0	700	*	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	697	SN	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	696	SLC	-0.60	-0.61	-0.63	-0.11	-0.11	-0.11	0.18	0.18	0.18	0.29	0.29	0.28	0.07	0.07	0.07
00	0	691	SAN	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	690	SIGW	0.32	0.31	0.29	0.08	0.07	0.07	0.24	0.24	0.24	3.48	3.09	2.58	0.09	0.09	0.09
00	0	683	SJI	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	1.41	1.35	0.58	0.14	0.14	0.12
00	0	682	SM	0.75	0.75	0.74	1.04	1.04	1.03	1.40	1.39	1.39	1.23	1.22	1.21	0.47	0.46	0.46
00	0	678	SBN	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	675	RSS	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	673	RSP	0.09	0.08	0.06	0.04	0.04	0.03	0.47	0.47	0.45	6.01	5.90	4.92	0.38	0.37	0.36
00	0	671	RR	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	665	RI	0.28	0.28	0.24	0.24	0.24	0.20	0.86	0.86	0.82	1.45	1.45	1.32	0.43	0.43	0.40
00	0	664	LV	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	659	PENE	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	656	CEE	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	7.86	6.21	4.57	0.35	0.34	0.34
00	0	655	QAP	0.30	0.30	0.28	0.06	0.05	0.05	0.18	0.18	0.18	0.98	0.96	0.89	0.04	0.04	0.04
00	0	651	PCN	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	648	PJR	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	647	PHD	0.51	0.51	0.43	0.30	0.29	0.24	0.57	0.57	0.55	3.55	3.52	2.78	0.59	0.58	0.56
00	0	645	PFU	0.24	0.24	0.17	0.15	0.15	0.10	0.64	0.64	0.59	1.84	1.82	1.39	0.26	0.26	0.24
00	0	644	PVS	0.19	0.18	0.16	0.05	0.04	0.04	0.23	0.23	0.23	17.70	15.75	13.25	0.42	0.42	0.42
00	0	634	PNW	0.53	0.53	0.43	0.44	0.42	0.27	0.82	0.81	0.63	2.36	2.20	1.26	0.24	0.24	0.19
00	0	632	PRTD	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	631	PW	-0.21	-0.21	-0.27	-0.08	-0.08	-0.09	0.36	0.36	0.35	0.68	0.68	0.64	0.21	0.21	0.21
00	0	629	PCY	0.36	0.36	0.24	0.37	0.36	0.20	1.02	1.02	0.82	1.96	1.90	1.03	0.26	0.26	0.21
00	0	627	PS	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	619	PIM	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	3.59	3.56	2.85	0.44	0.44	0.42
00	0	616	PCV	0.41	0.41	0.38	0.83	0.81	0.63	1.99	1.97	1.65	2.42	2.37	1.93	0.59	0.58	0.49

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				5			6			7			8			9		
1	2	3	4	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
00	0	603	OCE	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	587	OCTR	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	586	CTF	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	582	NFD	0.39	0.39	0.35	0.26	0.26	0.22	0.65	0.65	0.62	0.60	0.60	0.54	0.15	0.15	0.14
00	0	577	NSS	0.24	0.24	0.20	0.18	0.18	0.15	0.75	0.75	0.73	1.63	1.62	1.41	0.27	0.27	0.26
00	0	561	*	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	560	*	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	554	NE	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	553	NLG	0.43	0.43	0.42	0.37	0.37	0.36	0.86	0.86	0.86	0.41	0.41	0.41	0.25	0.25	0.25
00	0	552	MH	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	551	NS	0.26	0.26	0.24	0.18	0.18	0.17	0.70	0.70	0.69	1.01	1.00	0.85	0.06	0.06	0.06
00	0	549	NFE	-1.11	-1.12	-1.20	-0.61	-0.61	-0.61	0.54	0.54	0.51	1.87	1.85	1.45	0.30	0.30	0.28
00	0	548	MCSA	0.27	0.24	0.20	0.06	0.06	0.05	0.24	0.23	0.23	2.68	2.33	1.91	0.10	0.10	0.10
00	0	547	*	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	546	NYSW	0.04	0.04	-0.04	0.01	0.01	-0.01	0.25	0.25	0.24	0.30	0.30	0.27	0.06	0.06	0.06
00	0	542	NYD	0.15	0.15	0.13	0.16	0.16	0.12	1.05	1.04	0.96	0.75	0.74	0.69	0.22	0.22	0.20
00	0	537	NEZP	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	534	NLC	0.19	0.18	0.11	0.07	0.07	0.04	0.36	0.36	0.33	1.33	1.30	1.02	0.12	0.12	0.11
00	0	530	NN	-0.88	-0.90	-1.09	-0.18	-0.18	-0.20	0.21	0.20	0.19	8.39	6.00	5.43	0.64	0.64	0.58
00	0	525	NAP	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	524	*	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	522	METW	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	515	MI	0.27	0.26	0.23	0.07	0.07	0.06	0.26	0.26	0.26	1.05	1.02	0.84	0.04	0.04	0.04
00	0	513	IAT	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	511	ME	-0.86	-0.88	-1.02	-0.21	-0.21	-0.22	0.24	0.24	0.21	0.54	0.54	0.50	0.26	0.26	0.23
00	0	510	MDW	0.20	0.20	0.19	0.12	0.12	0.12	0.61	0.61	0.61	1.01	1.00	1.00	0.27	0.27	0.27
00	0	509	MB	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	507	MCV	0.42	0.40	0.37	0.17	0.16	0.15	0.40	0.40	0.40	3.80	3.65	3.41	0.64	0.63	0.63
00	0	506	MSE	0.32	0.32	0.29	0.22	0.22	0.19	0.69	0.69	0.66	2.72	2.69	2.46	0.43	0.42	0.41
00	0	502	MISS	0.09	0.07	0.05	0.06	0.05	0.03	0.69	0.67	0.67	1.06	1.02	0.94	0.26	0.25	0.25
00	0	500	MTR	-0.14	-0.15	-0.16	-0.05	-0.05	-0.06	0.38	0.37	0.37	-1.34	-1.33	-1.17	-0.07	-0.07	-0.06
00	0	498	MCRB	0.15	0.15	0.15	0.13	0.13	0.13	0.86	0.86	0.85	1.60	1.60	1.57	0.29	0.28	0.28
00	0	497	MGA	0.43	0.43	0.39	0.19	0.18	0.16	0.43	0.42	0.41	1.32	1.30	1.11	0.14	0.14	0.13
00	0	493	*	0.22	-0.19	-0.90	0.00	-0.00	-0.01	0.01	0.01	0.01	18.00	6.30	2.98	0.06	0.06	0.06
00	0	484	MTFR	0.07	0.05	-0.11	0.00	0.00	-0.01	0.06	0.06	0.05	5.46	5.34	4.32	0.20	0.20	0.20
00	0	480	MNS	0.28	0.27	0.22	0.14	0.13	0.10	0.49	0.48	0.47	2.77	2.71	2.25	0.35	0.34	0.33
00	0	475	MNJ	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	471	MSTR	-0.15	-0.18	-0.43	-0.03	-0.03	-0.06	0.17	0.17	0.15	1.22	1.15	0.71	0.08	0.08	0.07
00	0	466	MCR	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	1.15	1.14	1.03	0.24	0.24	0.22
00	0	462	*	0.48	0.48	0.47	0.36	0.36	0.35	0.76	0.76	0.76	1.15	1.15	1.13	0.41	0.41	0.41
00	0	460	MRS	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	459	MJ	0.51	0.50	0.50	0.55	0.54	0.53	1.08	1.07	1.07	5.70	5.45	5.07	0.59	0.59	0.59
00	0	453	*	0.45	0.44	0.43	0.20	0.20	0.19	0.45	0.45	0.45	2.94	2.88	2.79	0.46	0.46	0.46
00	0	451	LW	0.30	0.26	0.19	0.60	0.44	0.32	2.00	1.70	1.70	0.26	0.22	0.17	0.11	0.09	0.09
00	0	450	LPN	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	447	LBB	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	446	LNAC	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	2.85	2.83	2.80	0.69	0.69	0.69
00	0	445	LSO	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	443	LFB	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	23.33	10.42	5.35	0.46	0.43	0.43
00	0	442	LNW	0.25	0.25	0.25	0.20	0.20	0.19	0.78	0.78	0.78	3.39	3.33	3.22	0.33	0.33	0.33
00	0	441	LA	0.20	0.20	0.18	0.13	0.13	0.12	0.67	0.67	0.66	1.46	1.43	1.27	0.09	0.09	0.09
00	0	430	LUN	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00

1	2	3	4	5			6			7			8			9		
				(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
00	0	428	LAJ	0.36	0.36	0.31	0.21	0.21	0.17	0.58	0.58	0.56	2.67	2.64	1.96	0.24	0.24	0.23
00	0	427	LBS	0.23	0.23	0.22	0.05	0.04	0.04	0.20	0.20	0.20	0.42	0.42	0.42	0.18	0.18	0.18
00	0	426	LC	0.24	0.24	0.23	0.02	0.02	0.02	0.10	0.10	0.10	1.44	1.44	1.43	0.21	0.21	0.21
00	0	425	ISI	0.26	0.26	0.23	0.10	0.10	0.09	0.40	0.39	0.38	1.24	1.22	1.10	0.13	0.13	0.12
00	0	424	LEFW	0.20	0.16	0.10	0.12	0.09	0.06	0.58	0.56	0.56	1.78	1.26	0.84	0.09	0.08	0.08
00	0	423	LEF	0.55	0.55	0.54	0.36	0.36	0.35	0.65	0.65	0.65	1.74	1.71	1.67	0.21	0.21	0.21
00	0	420	LSBC	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	417	LSTT	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	2.58	2.37	0.63	0.17	0.17	0.14
00	0	407	LCBT	0.83	0.82	0.82	0.05	0.05	0.05	0.06	0.06	0.06	1.16	1.16	1.16	0.28	0.28	0.28
00	0	404	LT	0.39	0.39	0.36	0.44	0.43	0.39	1.13	1.13	1.09	1.69	1.88	1.47	0.23	0.23	0.22
00	0	403	KENN	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	402	KIT	-8.60	-8.61	-9.17	-0.69	-0.69	-0.68	0.08	0.08	0.07	2.07	2.04	1.43	0.21	0.21	0.20
00	0	401	KCT	0.01	0.01	-0.05	0.00	0.00	-0.00	0.06	0.06	0.06	2.05	2.04	1.96	0.17	0.17	0.17
00	0	398	LAL	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	366	HITD	0.31	0.31	0.25	0.20	0.20	0.14	0.64	0.63	0.56	0.45	0.45	0.42	0.22	0.22	0.19
00	0	359	*	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	357	IHB	0.18	0.18	0.15	0.19	0.18	0.15	1.04	1.04	0.99	0.94	0.94	0.87	0.37	0.37	0.35
00	0	352	*	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	341	*	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	340	*	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	337	*	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	334	HBI	0.21	0.14	-0.59	0.12	0.08	-0.14	0.60	0.55	0.23	4.63	3.55	1.00	0.61	0.56	0.24
00	0	331	HSW	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	329	HBS	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	328	HE	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	324	*	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	323	GU	-0.08	-0.12	-0.48	-0.02	-0.03	-0.09	0.26	0.25	0.19	0.67	0.64	0.41	0.11	0.10	0.08
00	0	321	GJ	0.46	0.44	0.23	0.17	0.16	0.07	0.37	0.37	0.29	0.78	0.77	0.65	0.32	0.32	0.25
00	0	320	GNWB	0.30	0.30	0.28	0.11	0.10	0.10	0.35	0.35	0.34	1.75	1.75	1.70	0.42	0.42	0.41
00	0	319	GWIN	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	314	GMRC	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	312	GEW	0.15	0.14	0.10	0.08	0.07	0.05	0.53	0.52	0.51	1.16	1.15	1.03	0.21	0.21	0.20
00	0	311	GWR	0.41	0.40	0.37	0.17	0.17	0.15	0.43	0.43	0.40	1.45	1.44	1.36	0.40	0.40	0.38
00	0	307	GNA	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	1.54	1.52	1.50	0.57	0.57	0.57
00	0	302	GBB	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	300	GSF	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	298	GANO	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	293	GHH	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	2.21	2.13	0.81	0.12	0.12	0.11
00	0	290	GM	0.45	0.45	0.44	0.41	0.40	0.40	0.90	0.90	0.90	1.07	1.06	1.05	0.34	0.34	0.34
00	0	287	GCW	0.54	0.53	0.50	0.25	0.24	0.23	0.46	0.45	0.45	3.58	3.20	2.70	0.17	0.17	0.17
00	0	282	FCR	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	277	FWB	0.12	0.11	0.08	0.04	0.03	0.03	0.31	0.31	0.31	1.26	1.16	1.02	0.07	0.07	0.07
00	0	273	FSDN	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	265	FP	0.10	0.03	-0.10	0.06	0.01	-0.06	0.61	0.55	0.55	21.00	4.45	1.90	0.26	0.23	0.23
00	0	264	FJG	-0.06	-0.08	-0.29	-0.01	-0.01	-0.04	0.17	0.16	0.15	0.91	0.90	0.81	0.27	0.27	0.24
00	0	260	FPE	0.34	0.33	0.16	0.22	0.21	0.09	0.64	0.64	0.56	1.72	1.70	1.13	0.38	0.38	0.34
00	0	248	*	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	247	EDW	0.66	0.65	0.60	0.33	0.33	0.27	0.50	0.50	0.45	3.53	3.48	3.02	0.66	0.66	0.60
00	0	245	EJR	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	242	EACH	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00

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				5			6			7			8			9		
1	2	3	4	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
00	0	241	ELS	-0.01	-0.01	-0.11	-0.00	-0.00	-0.03	0.26	0.25	0.23	0.36	0.35	0.30	0.05	0.05	0.05
00	0	234	EIWN	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	222	CIRR	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	220	DRM	0.43	0.42	0.29	0.17	0.16	0.09	0.39	0.39	0.33	7.50	7.07	4.36	0.60	0.59	0.50
00	0	219	DI	0.15	0.15	0.12	0.12	0.12	0.09	0.80	0.80	0.78	0.53	0.53	0.50	0.26	0.25	0.25
00	0	217	DS	0.20	0.19	0.17	0.08	0.08	0.07	0.43	0.43	0.43	2.32	2.27	2.12	0.23	0.23	0.23
00	0	215	CBL	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	204	DM	0.18	0.18	0.09	0.06	0.06	0.03	0.32	0.32	0.30	1.00	0.99	0.75	0.09	0.09	0.08
00	0	202	DMU	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	1.81	1.79	1.31	0.18	0.18	0.17
00	0	201	CCR	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
00	0	200	DCE	0.15	0.15	0.14	0.07	0.06	0.06	0.44	0.44	0.44	0.91	0.90	0.90	0.38	0.38	0.38
01	1	205	DIS	0.27	0.27	0.25	0.17	0.17	0.15	0.63	0.63	0.61	1.56	1.53	1.41	0.21	0.21	0.20
01	1	208	DTI	0.22	0.22	0.20	0.12	0.12	0.10	0.53	0.53	0.52	1.21	1.20	1.13	0.22	0.21	0.21
01	1	238	EJE	0.26	0.26	0.25	0.20	0.20	0.19	0.77	0.77	0.76	1.07	1.06	1.04	0.25	0.25	0.25
01	1	240	EI	0.12	0.12	0.10	0.08	0.08	0.06	0.64	0.64	0.63	0.90	0.89	0.81	0.12	0.12	0.12
01	1	308	GTW	0.21	0.21	0.19	0.13	0.13	0.12	0.64	0.64	0.63	1.04	1.04	0.98	0.16	0.16	0.16
01	1	354	ITC	0.21	0.20	0.17	0.12	0.11	0.09	0.56	0.56	0.54	0.97	0.97	0.88	0.19	0.19	0.18
01	1	364	IRN	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
01	1	413	LNE	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
01	1	419	LWV	-2.63	-3.47	-16.67	-0.01	-0.01	-0.05	0.00	0.00	0.00	0.18	0.18	0.14	0.03	0.03	0.02
01	1	429	LHR	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
01	1	436	LI	-0.72	-0.72	-0.73	-0.43	-0.43	-0.43	0.59	0.59	0.59	0.85	0.85	0.83	0.13	0.13	0.13
01	1	431	LV	0.16	0.16	0.12	0.06	0.06	0.05	0.39	0.39	0.38	0.96	0.95	0.83	0.09	0.09	0.09
01	1	456	MEC	0.11	0.11	0.09	0.05	0.05	0.04	0.48	0.48	0.47	1.05	1.04	0.99	0.14	0.14	0.13
01	1	550	NW	0.32	0.32	0.30	0.14	0.14	0.13	0.44	0.44	0.43	1.60	1.59	1.51	0.17	0.17	0.17
01	1	623	REG	0.08	0.06	0.06	0.03	0.03	0.03	0.45	0.45	0.44	0.75	0.75	0.71	0.09	0.09	0.09
01	1	622	PC	0.12	0.12	0.10	0.06	0.06	0.05	0.49	0.49	0.49	0.91	0.91	0.85	0.12	0.12	0.12
01	1	626	PIE	0.06	0.05	0.04	0.01	0.01	0.01	0.21	0.21	0.21	1.14	1.13	1.06	0.07	0.07	0.07
01	1	663	RFP	0.41	0.41	0.40	0.11	0.11	0.11	0.28	0.28	0.27	2.25	2.24	2.14	0.22	0.22	0.22
01	1	839	WM	0.25	0.25	0.23	0.09	0.09	0.09	0.37	0.37	0.37	2.55	2.53	2.38	0.26	0.26	0.26
01	1	61	BIE	0.25	0.25	0.24	0.14	0.13	0.13	0.54	0.54	0.53	1.50	1.49	1.44	0.21	0.21	0.20
01	1	59	BCK	0.03	0.03	0.03	0.03	0.03	0.03	1.02	1.02	1.02	0.98	0.98	0.98	0.32	0.32	0.32
01	1	56	BAB	0.04	0.04	0.01	0.01	0.01	0.00	0.31	0.31	0.30	0.99	0.98	0.89	0.09	0.09	0.09
01	1	69	BM	0.14	0.14	0.12	0.07	0.07	0.06	0.49	0.49	0.48	1.04	1.03	0.94	0.12	0.12	0.11
01	1	105	CF	0.04	0.04	0.04	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
01	1	125	CO	0.24	0.24	0.23	0.10	0.10	0.09	0.42	0.42	0.41	1.17	1.17	1.10	0.13	0.13	0.13
01	1	120	CV	0.06	0.06	0.01	0.02	0.02	0.00	0.37	0.37	0.36	1.78	1.75	1.48	0.15	0.15	0.15
01	1	119	CNJ	0.10	0.10	0.08	0.04	0.04	0.03	0.43	0.43	0.42	0.58	0.58	0.56	0.11	0.11	0.11
01	1	129	CEI	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
01	1	143	CRI	-0.00	-0.01	-0.13	-0.00	-0.00	-0.02	0.17	0.17	0.17	1.72	1.71	1.31	0.12	0.12	0.12
01	1	195	DH	0.14	0.14	0.11	0.09	0.09	0.07	0.66	0.66	0.64	1.20	1.20	1.09	0.21	0.21	0.21
01	1	27	PRSL	-0.26	-0.27	-0.30	-0.19	-0.19	-0.20	0.71	0.70	0.67	0.17	0.17	0.17	0.33	0.33	0.31
01	1	50	BC	0.26	0.26	0.24	0.12	0.11	0.10	0.45	0.45	0.44	1.28	1.28	1.19	0.15	0.15	0.15
01	2	712	SCI	0.25	0.25	0.23	0.09	0.09	0.09	0.37	0.37	0.37	1.36	1.36	1.27	0.11	0.11	0.11

1	2	3	4	5			6			7			8			9		
				(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
01	2	724	SOU	0.27	0.27	0.27	0.12	0.12	0.12	0.45	0.45	0.44	1.68	1.67	1.61	0.17	0.17	0.17
01	2	444	LN	0.23	0.23	0.22	0.11	0.11	0.11	0.48	0.48	0.49	1.28	1.28	1.20	0.12	0.12	0.11
01	2	350	ICG	0.20	0.20	0.18	0.10	0.10	0.09	0.47	0.47	0.46	1.01	1.01	0.93	0.10	0.10	0.10
01	2	299	GA	0.22	0.22	0.20	0.13	0.13	0.11	0.58	0.57	0.57	0.85	0.85	0.80	0.13	0.13	0.13
01	2	263	FEC	0.26	0.26	0.24	0.11	0.11	0.10	0.43	0.43	0.42	2.60	2.77	2.57	0.19	0.19	0.19
01	3	268	FWD	0.24	0.24	0.22	0.13	0.13	0.12	0.55	0.54	0.54	0.80	0.79	0.75	0.15	0.15	0.15
01	3	216	DWP	0.75	0.75	0.74	0.55	0.55	0.54	0.74	0.74	0.73	1.98	1.96	1.92	0.16	0.16	0.16
01	3	213	DMIR	0.20	0.19	0.18	0.09	0.09	0.09	0.47	0.47	0.46	1.02	1.02	0.97	0.10	0.10	0.10
01	3	197	DRGW	0.25	0.25	0.25	0.12	0.12	0.12	0.48	0.48	0.47	1.52	1.51	1.47	0.15	0.15	0.15
01	3	400	KCS	0.23	0.23	0.22	0.14	0.14	0.13	0.55	0.55	0.59	1.06	1.05	0.98	0.10	0.10	0.10
01	3	482	SOO	0.31	0.31	0.25	0.17	0.17	0.15	0.54	0.54	0.53	1.98	1.98	1.81	0.23	0.23	0.23
01	3	490	MKT	0.21	0.21	0.19	0.10	0.10	0.09	0.49	0.49	0.49	0.81	0.80	0.73	0.10	0.10	0.10
01	3	494	MP	0.28	0.28	0.27	0.12	0.12	0.12	0.45	0.45	0.44	1.44	1.44	1.36	0.15	0.15	0.15
01	3	721	SP	0.21	0.21	0.21	0.09	0.09	0.09	0.44	0.44	0.44	1.43	1.43	1.38	0.14	0.14	0.14
01	3	693	SLSF	0.24	0.24	0.23	0.14	0.14	0.13	0.57	0.57	0.56	1.09	1.05	1.01	0.11	0.11	0.11
01	3	694	SSW	0.22	0.22	0.21	0.08	0.08	0.07	0.35	0.35	0.35	2.38	2.37	2.27	0.18	0.18	0.17
01	3	559	NWP	0.13	0.13	0.11	0.05	0.05	0.04	0.40	0.39	0.39	1.04	1.02	0.90	0.06	0.06	0.05
01	3	840	WP	0.15	0.15	0.14	0.08	0.08	0.07	0.51	0.51	0.50	2.16	2.15	2.10	0.45	0.45	0.44
01	3	762	TM	0.19	0.17	0.13	0.08	0.08	0.06	0.48	0.47	0.46	3.39	3.33	2.86	0.39	0.38	0.38
01	3	769	TPW	0.28	0.28	0.27	0.33	0.32	0.30	1.17	1.16	1.13	1.03	1.02	0.97	0.26	0.26	0.25
01	3	802	UP	0.25	0.25	0.24	0.11	0.11	0.11	0.45	0.45	0.44	0.74	0.74	0.72	0.08	0.08	0.08
01	3	22	ATSF	0.16	0.16	0.17	0.09	0.09	0.08	0.50	0.50	0.50	1.55	1.54	1.46	0.13	0.13	0.13
01	3	145	BI	0.18	0.18	0.16	0.14	0.14	0.12	0.78	0.78	0.76	1.13	1.13	1.03	0.18	0.14	0.18
01	3	140	MILW	-0.02	-0.02	-0.04	-0.01	-0.01	-0.03	0.70	0.70	0.68	0.93	0.93	0.83	0.13	0.13	0.12
01	3	157	CS	0.20	0.20	0.18	0.06	0.06	0.05	0.30	0.30	0.29	1.03	1.02	0.99	0.13	0.13	0.12
01	3	131	CNW	0.20	0.20	0.18	0.20	0.20	0.17	1.00	1.00	0.96	0.89	0.89	0.81	0.21	0.21	0.20
01	3	76	BN	0.19	0.19	0.17	0.09	0.09	0.08	0.46	0.46	0.46	1.29	1.28	1.20	0.12	0.12	0.12

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APPENDIX J

CONRAIL: BACKGROUND AND ECONOMIC IMPACTS

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BACKGROUND

The bankruptcy of the Penn Central Railroad and the poor financial condition of other railroads in the Northeastern United States resulted in Congress passing the Regional Rail Reorganization (3-R) Act of 1973, which established the United States Railway Association (USRA) to plan and oversee the financing of the reorganization of the bankrupt northeastern railroads.

The Congress originally authorized $2.1 billion to assist the new corporation in rehabilitating its facilities and upgrading services. The Consolidated Rail Corporation was established to operate the bankrupt railroads and to consolidate and restructure them. On April 1, 1978, CONRAIL began operations as a private rail carrier.

Seven bankrupt railroads operating in the Northeast and Midwest were combined into the Consolidated Rail Corporation. CONRAIL was created under a series of Congressional Acts. The new company was comprised of the properties of the Penn Central, Erie Lackawanna, Central of New Jersey, Lehigh Valley, Lehigh and Hudson River, and the Ann Arbor Railway Company.

CONRAIL is by far the nation's largest railroad company. It is also a carrier with severe and continuing financial difficulties. Over the past two years CONRAIL lost $560 million, an amount which to a considerable extent exceeded expectations. In 1977 CONRAIL lost about $100 million more than anticipated. CONRAIL'S losses are, both directly and indirectly, made up by Federal government subsidies.

CONRAIL's business plan for 1978-82 foresees revenues, costs, and efficiency levels that will require Federal assistance beyond the $2.026 billion already appropriated. CONRAIL anticipates that freight volume between 1978 and 1982 will be 10 percent below the previous forecast and that operating efficiencies will improve somewhat more slowly than envisioned. The result is that CONRAIL's net income for the period will be an estimated $1.5 billion less, and that it will require $1.3 billion more in Federal funds than has been appropriated to date.

CONRAIL's need for subsidy may be even greater. Small changes in the margin between revenues and costs have a very large impact on CONRAIL's need for Government assistance. A 1 percent shortfall in revenue between 1978 and 1982 would require increases in Federal assistance of $189 million, or 15 percent more than CONRAIL's $1.3 billion estimate.

The 1978-82 business plan assumes a dramatic turnaround of CONRAIL's recent declines in traffic volume and revenue, along with substantial cost savings based on significant increases in efficiency. If this assumption holds and is accompanied by extremely favorable economic and operating conditions, the business plan indicates that CONRAIL could require a little less than the estimated $1.3 billion in additional Federal assistance. Under this optimistic case, CONRAIL would be self-sufficient by 1982. On the other hand with unfavorable conditions, CONRAIL could need as much as $3.8 billion in additional government funds during the next 5 years. This pessimistic case would also require a continuing need for government investment beyond 1982.

Based on CONRAIL's performance to date, the railroad's 1978-82 forecasts appear very optimistic, with a significant likelihood that more tha $1.3 billion in additional Federal assistance will be required.

Serious deficiencies in efficiency, service and revenues became evident during 1977. It has become clear that there had been a "degradation" of service. CONRAIL service qulaity continued to deteriorate until February 1978, when a low point was reached. The service situation was so serious that CONRAIL's service affected the entire nation's car supply. If these trends are not reversed quickly and convincingly, CONRAIL's 1978-82 business plan will be far too optimistic.

CONRAIL's need for additional funds has resulted from:

- Lower than anticipated freight revenues, and
- Greater than anticipated costs for maintaining equipment, and for equipment rental and related expenses.

CONRAIL's 1977 freight revenues were $317 million short of expectations primarily because its volume of traffic had declined steadily.

The economic health of the nation, particularly the Northeast, is an important determinant of the volume of freight carried by CONRAIL. CONRAIL's service area is not growing as fast as certain other regions, but it is experiencing absolute growth and the demand for freight services has been increasing. Nevertheless, total rail carloadings, particularly CONRAIL's, declined in 1977:

Change in carloadings, 1976 - 1977	
United States	-0.7%
Eastern District	-4.3%
CONRAIL	-5.5%

It is apparent that CONRAIL lost some of its share of the rail market:

	CONRAIL's SHARE	
MARKET	1976	1977
United States	22.7%	21.6%
Eastern District	39.3%	38.8%

CONRAIL's diminishing freight volume reflects two major problems:

1. CONRAIL has provided poor service, and its customers have turned to competing rail carriers as well as other modes. A key measure of service performance -- the proportion of loaded cars which arrived no more than one day behind schedule -- had deteriorated substantially since CONRAIL began operations. For the year 1977 CONRAIL's performance deteriorated some 5 percent compared with 1976.

2. CONRAIL faced a series of unpredictable external crises in 1977: two harsh winters; coal, iron, ore, and dock strikes; and the Johnstown flood. These reduced the demand for CONRAIL services and delayed some freight movements. Revenue lost in 1977 from these factors is estimated at $119 million.

CONRAIL has experienced equipment costs higher than anticipated for two principal reasons:

- The physical plant, particularly the car fleet, conveyed to CONRAIL was in worse shape than anticipated,
- CONRAIL has a major problem with its car utilization.

Labor productivity in CONRAIL is low. CONRAIL's labor costs now exceed 60% of revenues, which exceeds the cost/revenue ratio of any other railroad. The management of CONRAIL has alos been criticized. In a recent GAO report, managment was criticized for poor equipment utilization. CONRAIL had failed in its efforts to bring car utilization up to the 1973 Penn Central rate.

The overall prognosis for CONRAIL does not appear to be good. Its revenues are dropping as shippers seem to be increasingly diverting their business to competing modes of transportation. CONRAIL continues to lose what would otherwise appear to be its projected share of a growing market in the Northeast.

Economic Impact

Because of its size and location, the expense of a noise regulation can be expected to fall heavily on CONRAIL. CONRAIL has a large number of railroad yards, many of which are in areas of high population density. CONRAIL operates about 790 yards based on information compiled by the Federal Railroad Association of the Department of Transportation. Although CONRAIL has the largest number of yards, the number is not out of proportion to its size. Relative to its size (measured in revenues), the number of yards can be considered as average.

In absolute terms CONRAIL's yard properties and operations are extensive. CONRAIL's yard switching operations far exceed those of any railroad company. About 30 percent of the nation's total yard operations are being carried out by CONRAIL.

Listed below are the estimated costs for each of four noise control regulatory study levels in terms of capital investment and annualized costs. The cost elements comprising the various study levels have been previously presented in detail in Section 7 and, therefore, the data indicated for CONRAIL are shown as totals for these study levels along with the total number of yards affected at each level.

		Estimated Costs (millions of dollars)	
Study Level	Number of Yards	Capital	Annualized
1	223	5,707.3	2,144.6
2	522	6,790.3	2,626.5
3	789	125,050.7	66,726.2
4	789	188,097.2	91,494.1

A comparison was made between CONRAIL and the total number of Class I line haul roads (1976-1977 list of Class I railroads in accordance wih the ICC classification system) in respect to the categories of interest, namely the number of yards and estimated costs for each study level. The results of this comparison are displayed below in terms of percentages to show CONRAIL's portion of the total number of yards and estimated costs for Class I roads only to meet the various regulatory study levels..

Percent of Total for Class I Roads Only

		Estimated Costs	
Study Levels	Number of Yards	Capital	Annualized
1	19	14	16
2	22	14	17
3	21	22	21
4	21	23	22

As an example, an examination was made to determine the impact on demand if CONRAIL is allowed to pass on all of the costs required to meet particular noise regulatory levels. For the least stringent study level (study level 1) there would be a decrease in demand of less than 0.05 percent. For one of the more stringent study levels (level 3) the decrease in demand would range from 0.8 to 3.6 percent.

CONRAIL employed approximately 95,000 persons as of March 1977. If we assume that the number of employees will decrase in the same proportion as the decrease in adjusted revenues derived from rail services, employment would decrease from about 30 to 120 employees to implement study level 2 and from about 700 to 3100 employees to implement study level 3. This is the worst case situation and does not take into account the increased employment that will be required to install and operate the required noise abatement technology.

In 1977 CONRAIL planned to spend $640 million on capitalized maintenance of way expenditures, additions and improvements, nonrevenue equipment and revenue equipment. Capitalized expenditures required for study levels 1-4 range from 0.4 percent to 13.6 percent of this planned capitalization expenditure.

In 1977 CONRAIL had total operating revenues of $3,219 million. Total capital costs for study levels 1-4 range from $5.7 million to $188.1 million. This is about 0.2 percent to 5.8 percent of total revenues. Annualized costs for study levels 1-4 range from $2.1 million to $91.5 million. This is approximately 0.07 percent to 2.0 percent of total operating revenues.

Recent studies have shown that partial price elasticities of demand weighted by railroad revenue shares range from -0.39 to -1.41. From these estimates gross estimates of ranges on the demand for rail transportation and employment can be calculated.

If CONRAIL is not allowed to raise its prices, the cost to meet the noise regulations will have an effect on the demand for rail service.

REFERENCES

1. Report to Congress on CONRAIL Performance, 1977, United States Railway Association, Washington, D. C., May 31, 1978.

2. C&D 78-174, CONRAIL Faces Continuing Problems, U. S. General Accounting Office, Washington, D. C., October 6, 1978.

3. Other materials from trade press such as Railway Age and newspaper articles.

APPENDIX K

INDUSTRY PROFILE DATA

TABLE K-1
LOCOMOTIVE AND FREIGHT CAR INVENTORY
CLASS I LINE-HAUL RAILROADS (1976)

ROAD	NUMBER OF LOCOMOTIVE UNITS			FREIGHT CARS ON LINE
	YARD SERVICE	ROAD FREIGHT SERVICE	ROAD PASSENGER SERVICE	
EASTERN DISTRICT				
BALTIMORE & OHIO	143	800	0	73,896
BANGOR & AROOSTOOK	3	32	0	3,850
RESSEMER & LAKE ERIE	1	62	0	3,821
BOSTON & MAINE	61	104	0	6,870
CANADIAN PACIFIC - IN MAINE	1	20	3	21
CENTRAL VERMONT	2	14	0	505
CHESAPEAKE & OHIO	90	874	0	70,811
CHICAGO & ILLINOIS MIDLAND	8	13	0	765
CONRAIL	1,856	2,898	165	218,179
DELAWARE & HUDSON	39	125	0	7,827
DETROIT & TOLEDO SHORE LINE	6	10	0	1,008
DETROIT, TOLEDO & IRONTON	21	50	0	5,642
ELGIN, JOLIET & EASTERN	58	45	0	12,490
GRAND TRUNK WESTERN	91	92	3	15,527
ILLINOIS TERMINAL	20	15	0	1,935
LONG ISLAND	26	23	40	1,235
MAINE CENTRAL	17	50	0	3,492
NORFOLK & WESTERN	319	1,190	2	103,917
PITTSBURGH & LAKE ERIE	78	22	2	16,670
RICHMOND, FREDERICKSBURG & POT.	15	26	0	1,290
WESTERN MARYLAND	1	116	0	8,460
TOTAL EASTERN DISTRICT	2,856	6,581	215	558,211
SOUTHERN DISTRICT				
CLINCHFIELD	12	91	1	4,310
FLORIDA EAST COAST	10	47	0	2,952
GEORGIA	7	26	0	2,769
ILLINOIS CENTRAL GULF	165	884	25	62,752
LOUISVILLE & NASHVILLE	154	838	0	74,017
SEABOARD COAST LINE	213	1,087	0	76,957
SOUTHERN RY. SYSTEM	193	1,115	17	79,056
TOTAL SOUTHERN DISTRICT	754	4,088	43	302,813
WESTERN DISTRICT				
ATCHISON, TOPEKA & SANTA FE	163	1,552	0	76,909
BURLINGTON NORTHERN	516	1,644	21	119,250
CHICAGO & NORTH WESTERN	168	707	58	48,223
CHICAGO, MILW., ST. PAUL & PAC.	217	535	22	40,295
CHICAGO, ROCK ISLAND & PACIFIC	151	433	27	33,530
COLORADO & SOUTHERN	13	92	0	2,969
DENVER & RIO GRANDE WESTERN	32	197	6	9,117
DULUTH, MISSABE & IRON RANGE	36	35	0	8,572
DULUTH, WINNIPEG & PACIFIC	3	36	0	780
FORT WORTH & DENVER	6	14	0	2,178
KANSAS CITY SOUTHERN	77	136	0	6,454
MISSOURI-KANSAS-TEXAS	47	119	0	10,213
MISSOURI PACIFIC	260	822	0	66,305
NORTHWESTERN PACIFIC	0	50	0	1,120
ST. LOUIS-SAN FRANCISCO	92	358	0	22,597
ST. LOUIS SOUTHWESTERN	71	190	0	10,034
SOO LINE	55	172	0	14,802
SOUTHERN PACIFIC CO.	544	1,599	24	87,029
TEXAS MEXICAN	6	7	0	558
TOLEDO, PEORIA & WESTERN	4	27	0	889
UNION PACIFIC	247	1,171	0	67,944
WESTERN PACIFIC	12	134	0	5,372
TOTAL WESTERN DISTRICT	2,720	10,030	158	635,140
TOTAL UNITED STATES	6,330	20,699	416	1,496,164

TABLE K-2

CLASS I SWITCHING AND TERMINAL COMPANIES

Uniform Alpha Code	(1977)
ALQS	Aliquippa and Southern RR Co.
ALS	Alton & Southern RR Co.
BOCT	Baltimore & Ohio Chicago Terminal RR Co.
BRC	Belt RR Co. of Chicago
BS	Birmingham Southern RR Co.
CBL	Conemaugh & Black Lick RR Co.
CUVA	Cuyahoga Valley RR Co.
HBT	Houston Belt & Terminal RR Co.
IHB	Indiana Harbor Belt RR Co.
IU	Indianapolis Union
KCT	Kansas City Terminal RR Co.
KIT	Kentucky & Indiana Terminal RR Co.
LT	Lake Terminal RR Co.
MCRR	Monongahela Connecting RR Co.
PBR	Patapsco & Black Rivers RR Co.
PBNE	Philadelphia, Bethlehem & New England RR Co.
PTM	Portland Terminal Co.
SB	South Buffalo RR Co.
TRRA	Terminal RR Assoc. of St. Louis
TPMP	Texas Pacific - Missouri Pacific Terminal RR Co. of New Orleans
URR	Union RR Co.

Uniform Alpha Code	(1978)
URR	Union RR Co.

Table K-3. TABULATION OF RAILROAD COMPANIES, INCLUDING ICC CLASS DESIGNATION, REGION AND DISTRIBUTION OF YARDS BY TYPE

Legend:

IRR ≡ ACI Code

ARR ≡ Uniform Alpha Code

C ≡ 1 if Class I
0 if Class II (1976/77)

R ≡ Region for Class I: 1 if Eastern
2 if Southern
3 if Western

NHM ≡ Number of Hump Yards

NFC ≡ Number of Flat Classification Yards

NFI ≡ Number of Flat Industrial Yards

NFS ≡ Number of Flat Small Industrial Yards

ITOTAL ≡ Total Number of Yards

		1976 CLASS	REGION	NUMBER OF YARDS				
IRR	ARR	C	R	NHM	NFC	NFI	NFS	ITOTAL
2	ABB	0	0	0	0	2	0	2
3	ACY	0	0	0	2	1	0	3
4	AWW	0	0	0	0	2	0	2
9	AR	0	0	0	0	0	1	1
10	AA	0	0	0	2	2	0	4
11	AFA	0	0	0	0	1	0	1
12	AN	0	0	0	0	1	1	2
13	ARA	0	0	0	0	1	0	1
14	ABL	0	0	0	0	1	0	1
16	ALM	0	0	0	0	1	1	2
18	ALQS	0	0	0	0	1	1	2
19	AMC	0	0	0	0	0	1	1
20	AMR	0	0	0	0	0	1	1
21	ADN	0	0	0	0	1	0	1

IRR	ARR	1976 CLASS C	REGION R	NUMBER OF YARDS NHM	NFC	NFI	NFS	ITOTAL
22	ATSF	1	3	4	54	37	78	173
23	AWP	0	0	0	0	1	1	2
27	PRSL	1	0	0	0	4	10	14
31	AEC	0	0	0	0	0	2	2
32	ALS	0	0	1	0	0	0	2
35	ANR	0	0	0	0	1	1	2
38	AVL	0	0	0	0	0	1	1
42	ASAB	0	0	0	1	3	1	5
49	ARC	0	0	0	0	0	2	2
50	BO	1	1	7	60	51	63	181
56	BAR	1	1	0	3	2	1	6
59	BCK	1	0	0	0	1	0	1
61	BLE	1	1	0	4	2	0	6
64	BOCT	0	0	0	3	4	2	9
65	BS	0	0	0	0	4	2	6
69	BM	1	1	1	7	16	2	26
76	BN	1	3	10	89	85	113	297
78	BAP	0	0	0	2	0	2	4
79	BH	0	0	0	0	1	0	1
81	*	0	0	0	0	0	1	1
83	BRC	0	0	2	1	3	0	6
84	BXN	0	0	0	0	0	1	1
86	*	0	0	0	0	1	0	1
87	BML	0	0	0	0	1	0	1
91	BEDT	0	0	0	0	1	0	1
92	CAD	0	0	0	0	0	1	1
97	CTN	0	0	0	0	1	0	1
99	CF	0	0	0	0	0	1	1
100	CWR	0	0	0	0	1	0	1
101	CI	0	0	0	0	1	1	2
103	CN	0	0	0	0	2	1	3
104	CBC	0	0	0	0	1	1	2
105	CP	1	1	0	1	0	0	1
106	CRN	0	0	0	0	0	1	1
108	*	0	0	0	0	0	1	1
109	*	0	0	0	4	4	2	10
111	CIC	0	0	0	0	2	0	2
112	CCT	0	0	0	0	1	0	1
113	CARR	0	0	0	0	0	1	1
114	CACV	0	0	0	0	1	0	1
117	CHR	0	0	0	0	1	0	1

		1976 CLASS	REGION	NUMBER OF YARDS				
IRR	ARR	C	R	NHM	NFC	NFI	NFS	ITOTAL
118	CGA	0	0	1	2	8	19	30
119	CNJ	1	0	0	3	7	3	13
120	CV	1	1	0	2	3	1	6
124	CHV	0	0	0	0	1	1	2
125	CO	1	1	5	46	30	32	113
129	CEI	1	1	0	7	3	3	13
130	CIM	0	0	0	2	2	2	6
131	CNW	1	3	1	62	52	39	154
139	CHTT	0	0	0	1	1	2	4
140	MILW	1	3	3	47	42	53	145
141	CPLT	0	0	0	0	0	2	2
143	CRI	1	0	0	2	3	0	5
145	RI	1	3	2	27	34	40	103
147	CSL	0	0	0	0	1	0	1
150	CIW	0	0	0	0	1	0	1
153	CNTP	0	0	0	0	2	1	3
157	CS	1	3	0	2	4	6	12
158	CW	0	0	0	0	2	0	2
163	CLC	0	0	0	0	1	0	1
165	*	0	0	0	1	1	3	5
166	COP	0	0	0	0	1	0	1
168	CSS	0	0	0	0	0	1	1
169	CLP	0	0	0	0	1	0	1
177	CAGY	0	0	0	0	3	1	4
179	CHW	0	0	0	0	0	1	1
181	CLIF	0	0	0	0	0	1	1
186	CUVA	0	0	0	0	1	0	1
188	CLCO	0	0	0	0	1	0	1
191	DR	0	0	0	0	0	1	1
192	DRI	0	0	0	0	2	0	2
193	DVS	0	0	0	0	0	1	1
195	DH	1	1	0	9	11	3	23
196	DC	0	0	0	0	2	0	2
197	DRGW	1	3	1	3	6	20	30
200	DQE	0	0	0	0	0	2	2
201	CCR	0	0	0	0	1	0	1
202	DMU	0	0	0	1	0	0	1
204	DM	0	0	0	2	2	0	4
205	DTS	1	1	1	0	1	0	2
208	DTI	1	1	1	3	6	3	13
213	DMIR	1	3	0	3	4	2	9

		1976 CLASS	REGION	NUMBER OF YARDS				
IRR	ARR	C	R	NHM	NFC	NFI	NFS	ITOTAL
215	CBL	0	0	0	2	2	0	4
216	DWP	1	3	0	0	1	0	1
217	DS	0	0	0	0	0	3	3
219	DT	0	0	0	1	0	1	2
220	DMM	0	0	0	0	1	0	1
222	CIRR	0	0	0	0	1	1	2
234	ETWN	0	0	0	0	0	1	1
238	EJE	1	1	1	3	4	5	13
240	EL	1	0	2	26	35	28	91
241	ELS	0	0	0	0	1	0	1
242	EACH	0	0	0	0	0	1	1
245	EJR	0	0	0	0	1	0	1
247	EDW	0	0	0	0	1	0	1
248	*	0	0	0	0	0	1	1
260	FPE	0	0	0	2	0	0	2
263	FEC	1	2	0	3	3	3	9
264	FJG	0	0	0	0	1	0	1
265	FP	0	0	0	0	0	1	1
268	FWD	1	3	0	5	0	5	10
273	FRDN	0	0	0	0	0	1	1
277	FWB	0	0	0	0	0	1	1
282	FOR	0	0	0	0	1	0	1
287	GCW	0	0	0	0	0	1	1
290	GM	0	0	0	0	0	1	1
293	GHH	0	0	0	3	1	1	5
298	GANO	0	0	0	0	0	1	1
299	GA	1	2	0	1	1	5	7
300	GSF	0	0	0	2	0	2	4
302	GRR	0	0	0	0	0	1	1
307	GNA	0	0	0	0	0	1	1
308	GTW	1	1	0	12	11	1	24
311	GWR	0	0	0	0	1	0	1
312	GBW	0	0	0	2	2	1	5
314	GMRC	0	0	0	2	1	0	3
319	GWIN	0	0	0	0	1	0	1
320	GNWR	0	0	0	0	1	0	1
321	GJ	0	0	0	0	1	0	1
323	GU	0	0	0	0	1	0	1
324	*	0	0	0	0	1	0	1
328	HE	0	0	0	0	0	1	1

		1976 CLASS	REGION	NUMBER OF YARDS				
IRR	ARR	C	R	NHM	NFC	NFI	NFS	ITOTAL
329	HBS	0	0	0	0	1	0	1
331	HSW	0	0	0	0	0	1	1
334	HRT	0	0	0	0	1	0	1
337	*	0	0	0	0	1	0	1
340	*	0	0	0	2	3	4	9
341	*	0	0	0	0	0	1	1
350	ICG	1	2	4	47	48	33	132
352	*	0	0	0	0	1	0	1
354	ITC	1	1	0	4	2	0	6
357	IHB	0	0	3	4	4	1	12
359	*	0	0	0	1	3	0	4
364	IRN	1	0	0	0	0	1	1
366	HPTD	0	0	0	0	1	0	1
398	LAL	0	0	0	0	1	0	1
400	KCS	1	3	0	8	8	12	28
401	KCT	0	0	0	1	0	0	1
402	KIT	0	0	0	2	3	0	5
403	KENN	0	0	0	0	2	0	2
404	LT	0	0	0	2	0	0	2
407	LDRT	0	0	0	0	0	1	1
413	LNE	1	0	0	0	2	1	3
417	LSTT	0	0	0	1	0	0	1
419	LWV	1	0	0	0	2	0	2
420	LSBC	0	0	0	0	1	0	1
423	LEF	0	0	0	0	0	1	1
424	LEFW	0	0	0	0	0	1	1
425	LSI	0	0	0	1	3	1	5
426	LC	0	0	0	0	0	1	1
427	LRS	0	0	0	0	0	1	1
428	LAJ	0	0	0	1	0	0	1
429	LHR	1	0	0	2	0	0	2
430	LUN	0	0	0	0	0	1	1
431	LV	1	0	4	7	14	9	34
436	LI	1	1	1	1	2	0	4
441	LA	0	0	0	3	2	3	8
442	LNW	0	0	0	0	0	1	1
443	LPB	0	0	0	0	0	1	1
444	LN	1	2	4	28	54	25	111
445	LSO	0	0	0	0	0	1	1
446	LNAC	0	0	0	0	0	1	1

		1976 CLASS	REGION	NUMBER OF YARDS				
IRR	ARR	C	R	NHM	NFC	NFI	NFS	ITOTAL
447	LBR	0	0	0	0	0	1	1
450	LPN	0	0	0	1	0	1	2
451	LW	0	0	0	0	0	1	1
453	*	0	0	0	0	0	1	1
456	MEC	1	1	0	3	2	3	8
459	MJ	0	0	0	0	0	1	1
460	MRS	0	0	0	0	1	0	1
462	*	0	0	0	0	0	4	4
466	MCR	0	0	0	0	1	0	1
471	MSTR	0	0	0	0	1	0	1
475	MNJ	0	0	0	0	0	1	1
480	MNS	0	0	0	2	0	2	4
482	SOO	1	3	0	20	11	13	44
484	MTFR	0	0	0	0	1	0	1
490	MKT	1	3	0	13	3	17	33
493	*	0	0	0	0	0	1	1
494	MP	1	3	3	34	30	68	135
497	MGA	0	0	0	1	5	0	6
498	MCRR	0	0	0	0	1	0	1
500	MTR	0	0	0	0	1	1	2
502	MISS	0	0	0	0	0	1	1
506	MSE	0	0	0	0	1	1	2
507	MOV	0	0	0	0	0	1	1
509	MB	0	0	0	0	1	1	2
510	MDW	0	0	0	0	0	1	1
511	ME	0	0	0	0	1	0	1
513	IAT	0	0	0	0	2	0	2
515	MI	0	0	0	1	3	0	4
523	METW	0	0	0	0	0	1	1
524	*	0	0	0	0	1	0	1
525	NAP	0	0	0	0	0	1	1
530	NN	0	0	0	0	1	3	4
534	NLC	0	0	0	0	1	1	2
537	NEZP	0	0	0	0	0	1	1
542	NYD	0	0	0	0	1	0	1
546	NYSW	0	0	0	1	1	1	3
547	*	0	0	0	0	1	4	5
548	MCSA	0	0	0	0	0	1	1
549	NPB	0	0	0	1	1	1	3
550	NW	1	1	7	70	54	49	180

		1976 CLASS	REGION	NUMBER OF YARDS				
IRR	ARR	C	R	NHM	NFC	NFI	NFS	ITOTAL
551	NS	0	0	0	2	3	4	9
552	MH	0	0	0	0	0	1	1
553	NLG	0	0	0	0	0	2	2
554	NB	0	0	0	0	1	0	1
559	NWP	1	3	0	1	1	5	7
560	*	0	0	0	0	1	0	1
561	*	0	0	0	0	1	0	1
577	NSS	0	0	0	1	0	2	3
582	NFD	0	0	0	1	1	0	2
586	OTR	0	0	0	0	1	0	1
587	OCTR	0	0	0	0	0	1	1
603	OCE	0	0	0	0	1	1	2
616	POV	0	0	0	0	1	0	1
619	PTM	0	0	0	1	1	0	2
622	PC	1	0	23	144	221	188	576
623	RDG	1	0	3	7	10	27	47
626	PLE	1	1	0	4	7	5	16
627	PS	0	0	0	1	1	2	4
629	PCY	0	0	0	1	2	0	3
631	PW	0	0	0	2	0	0	2
632	PRTD	0	0	0	2	0	0	2
634	PNW	0	0	0	0	1	0	1
644	PVS	0	0	0	0	0	1	1
645	PPU	0	0	0	2	2	1	5
647	PHD	0	0	0	1	0	0	1
648	PJR	0	0	0	1	1	0	2
651	PCN	0	0	0	0	0	1	1
655	QAP	0	0	0	0	0	2	2
656	QRR	0	0	0	0	0	1	1
659	PBNE	0	0	0	0	1	0	1
663	RFP	1	1	2	1	0	1	4
664	RV	0	0	0	0	1	0	1
665	RT	0	0	0	1	2	2	5
671	RR	0	0	0	0	2	0	2
673	RSP	0	0	0	0	1	0	1
675	RSS	0	0	0	0	0	1	1
678	SRN	0	0	0	0	0	1	1
682	SM	0	0	0	0	0	2	2
683	SJT	0	0	0	1	0	0	1
690	SLGW	0	0	0	0	0	1	1
691	SAN	0	0	0	0	0	1	1

		1976 CLASS	REGION	NUMBER OF YARDS				
IRR	ARR	C	R	NHM	NFC	NFI	NFS	ITOTAL
693	SLSF	1	3	2	17	19	38	76
694	SSW	1	3	1	10	1	10	22
696	SLC	0	0	0	0	0	1	1
697	SN	0	0	0	0	2	3	5
700	*	0	0	0	0	0	1	1
702	SDAE	0	0	0	0	1	0	1
705	SLAW	0	0	0	0	0	1	1
706	SSLV	0	0	0	0	1	0	1
707	SS	0	0	0	0	0	1	1
709	TSU	0	0	0	0	1	0	1
712	SCL	1	2	3	38	88	51	180
716	SERA	0	0	0	0	0	1	1
718	SBK	0	0	0	0	1	0	1
719	*	0	0	0	0	1	0	1
720	SIND	0	0	0	0	0	2	2
721	SP	1	3	8	29	58	116	211
724	SOU	1	2	8	30	48	58	144
727	SI	0	0	0	1	1	3	5
730	*	0	0	0	1	1	0	2
739	STE	0	0	0	0	1	0	1
741	SMV	0	0	0	1	1	1	3
746	*	0	0	0	0	0	1	1
750	TEXC	0	0	0	0	0	1	1
755	TAG	0	0	0	0	0	1	1
757	TRRA	0	0	1	2	5	0	8
758	TASD	0	0	0	0	3	0	3
759	TMBL	0	0	0	1	0	0	1
760	TP	0	0	1	10	4	15	30
761	TCT	0	0	0	0	1	1	2
762	TM	1	3	0	2	0	1	3
765	TSE	0	0	0	0	1	0	1
767	TENN	0	0	0	0	1	0	1
769	TPW	1	3	0	1	1	5	7
771	TT	0	0	0	0	2	1	3
779	TRC	0	0	0	0	0	1	1
782	TOV	0	0	0	0	0	1	1
783	TCG	0	0	0	0	0	1	1
784	TS	0	0	0	0	0	1	1
785	TAW	0	0	0	0	0	1	1
788	TNM	0	0	0	0	0	1	1
793	SJL	0	0	0	1	1	0	2

		1976 CLASS	REGION	NUMBER OF YARDS				
IRR	ARR	C	R	NHM	NFC	NFI	NFS	TOTAL
794	SMA	0	0	0	0	0	1	1
795	TN	0	0	0	0	1	0	1
799	SH	0	0	0	0	1	0	1
802	UP	1	3	4	31	31	70	136
803	URR	0	0	1	3	12	0	16
807	UT	0	0	0	0	1	0	1
808	UMP	0	0	0	0	2	0	2
809	UTR	0	0	0	0	0	1	1
811	UTAH	0	0	0	0	0	3	3
815	VAMD	0	0	0	0	0	2	2
817	VTR	0	0	0	1	2	1	4
826	WWV	0	0	0	0	0	1	1
828	WS	0	0	0	0	1	0	1
829	WOV	0	0	0	0	0	1	1
830	WYS	0	0	0	0	1	0	1
831	WIM	0	0	0	0	0	2	2
832	WSB	0	0	0	0	0	1	1
833	WYT	0	0	0	0	1	0	1
838	WRRC	0	0	0	0	0	1	1
839	WM	1	1	1	6	1	14	22
840	WP	1	3	0	5	6	10	21
841	WA	0	0	0	1	0	0	1
846	WSYP	0	0	0	0	0	1	1
848	WAG	0	0	0	0	2	0	2
850	WW	0	0	0	0	1	0	1
851	WNF	0	0	0	0	0	1	1
854	WSS	0	0	0	1	1	0	2
872	YVT	0	0	0	0	0	1	1
873	YW	0	0	0	0	0	1	1
875	YS	0	0	1	0	0	0	1
876	YAN	0	0	0	0	0	1	1
877	YN	0	0	0	0	2	0	2

Table K-4. TABULATION OF RAILROADS WHICH CHANGED ICC DESIGNATIONS BETWEEN 1976/77 AND 1978

Class I 1976/77 → Class II 1978

	UNIFORM ALPHA CODE	ACI CODE	RAILROAD NAME
1.	BAR	056	Bangor & Aroostook
2.	CP	105	Canadian Pacific
3.	CV	120	Central Vermong
4.	CEI	129	Missouri Pacific
5.	DTS	205	Detroit & Toledo Shore Line
6.	DWP	216	Duluth, Winnipeg & Pacific
7.	GA	299	Georgia
8.	ITC	354	Illinois Terminal
9.	MEC	456	Maine Central
10.	NWP	559	Northwestern Pacific
11.	RFP	663	Richmond, Fredericksburg & Potomac
12.	TM	762	Texas Mexican
13.	TPW	769	Toledo, Peoria & Western

Class II 1976/77 → Class I 1978

	UNIFORM ALPHA CODE	ACI CODE	RAILROAD NAME
1.	AGS	029	Alabama Great Southern
2.	CGA	118	Central of Georgia
3.	CNTP	153	Cincinnati, New Orleans & Texas Pacific
4.	LA	441	Louisiana & Arkansas

APPENDIX L

REFINEMENT TO COMPLIANCE COSTS FOR REGULATORY OPTION DECISION PROCESS

In Section 7, compliance cost estimates were developed for various regulatory study levels. The cost estimates to achieve the regulatory levels were developed from an analysis of each noise abatement procedure to establish an appropriate unit cost. Capital costs and annualized costs were derived from an inventory of facilities and equipment that required noise control and the estimated unit costs to obtain the needed noise reduction using best available technology. These costs were generated on the basis of typical types of facilities and equipment and aggregated to reach the total estimated compliance costs for the various regulatory levels analyzed. Based on the preliminary analyses and cost estimates made on curtailment of nighttime rail yard operations, further refinement of the cost data for this noise abatement procedure was warranted.

The data presented in Section 7 on night operations curtailment considered the suspension of rail yard activities from 10 p.m. to 7 a.m. Activities which normally would have taken place during this time period were assumed to be rescheduled for the two daytime shifts. Personnel performing operations involved in such facilities would be reassigned and provided the additional equipment, etc., to facilitate their normal operations. A cost savings in wages would be realized resulting from suspension of the night shift. The estimated costs presented in Section 7 concerning night operations curtailment focused on the capital costs for the purchase of additional switching locomotives and the annualized costs, including capitol recovery, as well as operation and maintenance costs of the additional equipment. It was assumed that the typical yard required a 50 percent increase in the number of its switching locomotives in order to provide the adjusted daytime shift manpower the capability to handle the traffic through the yard.

Since a refinement to this previous cost analysis was warranted to obtain a more realistic picture of yard operations and costs, additional information was collected and analyzed from several sources.* The information focused upon refining the estimated costs to accommodate the additional switching locomotives and additional through capacity required by suspending night operations in typical yards. Refinement of the estimated costs consist of the following items:

- Acquisition of additional land related to existing flat yards to accommodate the through capacity required by nighttime operations curtailment.
- Acquisition and installation of slow trackage and switches to accommodate and facilitate flat yard operations resulting from curtailment of night operations.

The estimated costs to expand yard land areas and lay additional track are based upon the assumption that receiving and classification areas would increase by 33 percent while the departure area would increase by 100 percent. For the cost calculations, all yards of a given type were considered to be medium activity, however, different yard geometries were assumed for each yard type as explained in Section 6 of the Background Document. The land values are identical to those used for estimating land acquisition costs in Section 7. The derivation of the land cost data is presented in Appendix D. The unit costs for additional track and switches along with estimated new track and switch requirements are indicated in Table L-1.

Table L-2 shows the revised annualized cost estimates that incorporate the refinement to costs associated with curtailment of nighttime activities. Costs for new track and land were annualized over a 30 year period. Maintenance costs for the additional land and equipment have also been included in the cost estimates. The total annualized costs for each type of rail yard are shown in Table L-2 also. They were calculated by multiplying the estimated cost for each type of yard by the total number of each yard type. The total number of yards by type are listed below.

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* Based upon personal communications via telephone contact with Engineers at the RF&P yard in Alexandria, Va., and Gellman Research Associates, Jenkinsville, Pa.

TABLE L-1

ADDITIONAL TRACK AND SWITCH REQUIREMENTS

Yard Type	No. of Tracks	Length of Track	Cost/ft.	No. of Switches	Cost/Switch ($\$10^3$)	Total Cost ($\$10^6$)
Hump Classification	-	-	-	-	-	-
Flat Classification	12	4300	$50	12	25	11.8
Industrial	10	4300	$50	10	25	2.5
Small Industrial	7	3300	$50	7	25	1.4

TABLE L-2

REVISED ANNUALIZED COST ESTIMATES BY YARD TYPE AND STUDY LEVEL

Yard Type	Cost ($000)							
	Level 1		Level 2		Level 3		Level 4	
	Per Yard	Total	Per Yard	Total	Per Yard	Total	Per Yard	Total
Hump Classification	29	3,600	35	4,400	231	28,600	1,005	124,600
Flat Classification	5	5,600	5	5,600	4,637	5,161,000	**	**
					7,013*	7,806,000*	31,832*	35,429,000*
Industrial	-		5	6,900	807	1,115,000	**	**
							12,075*	16,676,000*
Small Industrial	-				438	679,000	**	**

* Estimated costs include land acquisition to extend property line to achieve the regulatory study level and assumed noise abatement technology has achieved a property line of an L_{dn} 70.

** Denotes that estimated annualized costs would include Level 3 costs plus purchase of land for buffer zone to achieve this level (Level 4).

Type of Yard	Total Number of Yards
Hump Classification	124
Flat Classification	1113
Industrial	1381
Small Industrial	1551
GRAND TOTAL	4169

The estimated capital costs to achieve the regulatory study levels by type of yard are summarized in Table L-3.

Based upon the refined capital and annualized cost estimates to achieve the various regulatory study levels, several time-phased regulatory levels were considered as potential options. Table L-4 summarizes the key variables employed in the decision process.

The proposed regulations could directly affect two employment sectors: the railroad industry and suppliers of noise abatement materials and equipment. The railroad industry could experience a decrease of up to fourteen hundred employees. This decrease accounts for anticipated changes in the total operating revenues of railroads resulting from the estimated compliance costs to meet the regulation proposed. The suppliers on the other hand could experience an increase of up to two hundred employees. This increase takes into account the average employment change resulting from the procurement and fabrication of the noise control materials and equipment. The overall or net employment effect is, then, estimated to be an approximate twelve hundred worker decrease.

An analysis of economic impact of bankrupt roads as well as those recently reorganized to form the Consolidated Rail Corporation (Conrail) was conducted as well. The bankrupt roads included Boston and Maine; Chicago, Milwaukee, St. Paul & Pacific; Chicago, Rock Island & Pacific; and MOrristown & Erie. The estimated net employment decrease for these roads totals about 400 workers, with over 300 workers related to those firms comprising Conrail. (This net employment decrease is included in the overall employment impact total shown above for the proposed regulatory levels.)

TABLE L-3

ESTIMATED CAPITAL COSTS BY YARD TYPE AND STUDY LEVEL

Yard Type	Costs (thousands of dollars)			
	Level 1	Level 2	Level 3	Level 4
Hump Classification	122	148	470	2,441
Flat Classification	18	18	36,583*	**
Industrial/ Small Industrial	-	6	2,790*	**

* Estimated capital costs include all noise abatement procedures and the refined costs to achieve this regulatory study level.

** Indicates that costs for Level 4 would be greater than those of Level 3 because of need to acquire buffer land.

TABLE L-4

COMPARISON OF OPTIONS

OPTIONS	L_{dn} Level in dBA	Lead Times in Years	Average Annualized Benefits ΔENI 10^3	Annualized Costs \$ x 10^6	Ratio Average Benefit/ Cost	End-Year (2000) Benefits ΔENI 10^3	Capital Investment Costs \$ x 10^6
(1)	75	3	62.8	8.1	7.8	72.8	37.8
(2)	75	3	214.0	11.9	17.9	280.6	51.1
	70	6					
(3)	70	3	242.3	13.6	17.8	280.6	51.1
(4)	70	3	278.7	27.3	10.2	330.6	91.0
	65 (Hump Yards Only)	6					
(5)	70	3	584.8	4030.6	0.15	751.6	35,790.5[a]
	65	6	(584.8)	(5568.6)	(0.11)	(751.6)	(56,522.0)[b]

NC = Non-compatible Land Use, Residential/Commercial.
a = Transfer of nighttime activity to day time.
b = Purchase of buffer land to achieve a 5 dBA reduction in noise from L_{dn} 70 to L_{dn} 65.

In Section 6, railroad noise propagation and health and welfare models were described. There has been considerable debate as to what role, if any, health and welfare are to play in the agency's decision-making analysis for railroad noise regulations. The Association of American Railroads has argued that health and welfare are to be totally absent from the agency's consideration because there is no mention of health and welfare, per se, in Section 17 of the Act. We do not share this view.

The Noise Control Act of 1972, 42 U.S.C. 4901 et seq., which places the duty upon EPA to regulate noise, states "the policy of the United States to promote an environment for all Americans free from noise that jeopardizes their health or welfare". 42 U.S.C. 4901. Section 17 of that Act, which requires standards on the facilities and equipment of interstate rail carriers, directs EPA to set standards that reflect the degree of noise reduction achievable through application of the best available technology taking into account the cost of compliance. 42 U.S.C. 4916(a). While that charge does not include a specific balancing of the needs of public health and welfare, it is manifest that the standards cannot and should not be set in a void of information concerning those needs.

First, it is not possible to assess the best available noise reduction technology without having as a guide a noise control objective. There must be a target noise reduction criterion in order to assess how effective technology is in accomplishing its objective. Since the reason that noise is sought to be reduced by any level of government is to prevent the impingement on health and welfare that caused citizens to complain, it is reasonable that the noise descriptor used be one that relates best to health and welfare. For this reason, EPA has used L_{dn} as the descriptor to assess the effectiveness of various types of available technology and to identify the "best".

Second, it is not possible to meaningfully take into account the cost of compliance without having an objective toward which those costs are imposed. The very best available technology is not always affordable. By the same token, the greatest reasonable cost that could be imposed is not always justifiable by the objectives of the regulation. Yet the Noise Control Act does not say that no costs should be imposed upon the industry. Rather, it is inherent in Section 17(a) that the costs that are imposed for noise control must be reasonable. The only means of judging whether they are reasonable is to scrutinize what they purchase, and the only utility of noise reduction is the protection of health and welfare.

An additional way in which public health and welfare must affect cost determinations is in selecting the types of controls that the agency will require. If EPA, for instance, were to determine that the railroad industry could expend "X" million dollars per year for noise control, it would be irrational public policy to require that these funds be spent in areas where no one would benefit from them, if there was another way to benefit "Y" people by spending the same "X" million dollars per year.

In summary, EPA has concluded that public health and welfare plays an important role in setting standards under Section 17 of the Noise Control Act. It is not within the purview of the Act for the agency to set standards at costs that are unreasonable just because the public health and welfare would be served; for this reason, the standards proposed in this regulation do not require abatement to the levels necessary to provide total protection to the public health and welfare. Howver, in assessing what available technology can accomplish in terms of meaningful noise reduction, in determining the limits beyond which costs should not be imposed, and in selecting the types of controls that should be imposed at that level of expenditure, consideration of the effects of noise reduction on public health and welfare are within the intent of the Act.

Table L-5 lists the variation of rail yard noise impacts for several of the alternative reglatory levels (Options 1 through 5).

TABLE L-5

VARIATION OF RAILYARD NOISE IMPACT WITH ALTERNATIVE REGULATORY LEVELS

Maximum Allowable Noise Level at Railyard Boundary	Population Exposed To L_{dn} $\geq$ 55 dB	Equivalent Number of People Impacted (ENI)
BASELINE (without noise regulation)	3,946,490	1,116,410
OPTION 1		
All rail yards: L_{dn} = 75 dB by January 1, 1982.	3,754,880	1,078,690
OPTION 2		
(a) All rail yards: L_{dn} = 75 dB by January 1, 1982; and	3,754,880	1,078,690
(b) All rail yards: L_{dn} = 70 dB by January 1, 1985.	3,260,900	880,830
OPTION 3		
All rail yards: L_{dn} = 70 dB by January 1, 1982.	3,260,900	880,830
OPTION 4		
(a) All rail yards: L_{dn} = 70 dB by January 1, 1982; and	3,260,900	880,830
(b) Hump Classification yards only at L_{dn} = 65 dB by January 1, 1985.	3,115,400	830,810
OPTION 5		
(a) All rail yards: L_{dn} = 70 dB by January 1, 1982; and	3,260,900	880,830
(b) All rail yards: L_{dn} = 65 dB by January 1, 1985.	2,010,700	409,800

The baseline level indicates the population exposed to railroad facility and equipment generated noise equal to or greater than a day-night average sound level of 55 dB and the corresponding equivalent number of people impacted by this noise. The baseline level represents the unregulated case. The information shown for Options 1 through 5 illustrate the change in population exposed and impacted from railroad yard generated noise as a result of the time-phased regulatory levels.

APPENDIX H

FRACTIONAL IMPACT PROCEDURE

An integral element of an environmental noise assessment is to determine or estimate the distribution of the exposed population to given levels of noise for given lengths of time. Thus, before implementing a project or action, one should first characterize the existing noise exposure distribution of the population in the area affected by estimating the number of people exposed to different magnitudes of noise as described by metrics such as the Day-Night Average Sound Level (L_{dn}). Next, the distribtuion of people who may be exposed to noise anticipated as a result of adopting various projected alternatives should be predicted or estimated. We can judge the environmental impact by simply comparing these successive population distributions. This concept is illustrated in Figure 1 which compares the estimated distribution of the population prior to inception of a hypothetical project (Curve A) with the population distribution after implementation of the project (Curve B). For each statistical distribution, numbers of people are simply plotted against noise exposure where L_i represents a specific exposure in decibels to an arbitrary unit of noise. A measure of noise impact is ascertained by examining the shift in population distribution attributable either to increased or lessened project related noise. Such comparisons of population distributions allow us to determine the extent of noise impact in terms of changes in the number of people exposed to different levels of noise.

The intensity or severity of a noise impact may be evalutaed by comparing the degree of noise exposure with suitable noise effects criteria, which exist in the form of dose-response or cause-effect relationships. Using these criteria, the probability or magnitude of an anticipated effect can be statistically predicted from knowledge of the noise exposure incurred. Illustrative examples of the different forms of noise effects criteria are graphically displayed in Figure 2. In general, dose-response functions are statistically derived from noise

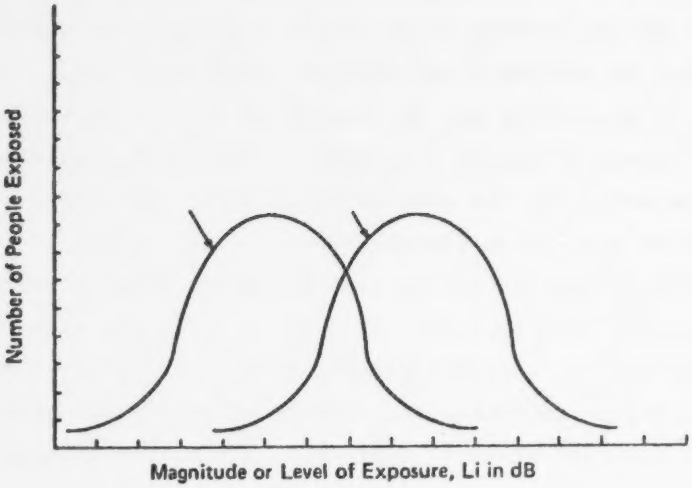

FIGURE 1. EXAMPLE ILLUSTRATION OF THE NOISE DISTRIBUTION OF POPULATION AS A FUNCTION OF NOISE EXPOSURE

effects information and exhibited as linear or curvilinear relationships, or combinations thereof. Although these relationships generally represent a statistical "average" response, they may also be defined for any given population percentile. The statistical probability or anticipated magnitude of an effect at a given noise exposure can be estimated using the appropriate function. For example, as shown in Figure 2 using the linear function, if it is established that a number of people are exposed to a value of L_j, the incidence of a specific response occurring within that population would be statistically predicted at 50 percent.

A more comprehensive assessment of environmental noise may be performed by cross-tabulating both indices of extensity (number of people exposed) and intensity (severity) of impact. To perform such an assessment we must first statistically estimate the given level, L_i, by applying suitable noise effects criteria. At each level, L_i, the impact upon all people so exposed is then obtained by simply comparing the number of people exposed with the magnitude or probability of the anticipated response. As illustrated in Figure 1, the extent of a noise impact is functionally described as a distribution of exposures. Thus, the total impact of all exposures is a distribution of people who are affected to varying degrees. This may be expressed by using an array or matrix in which the severity of impact at each L_i is plotted against the number of people exposed at that level. Table 1 presents a hypothetical example of such an array.

TABLE 1

EXAMPLE OF IMPACT MATRIX FOR A HYPOTHETICAL SITUATION

Exposure	Number of People	Magnitude or Probability of Response in Percent
L_i	1,200,000	4
L_{i+1}	900,000	10
L_{i+2}	200,000	25
L_{i+3}	50,000	50
...		
L_{i+n}	2,000	85

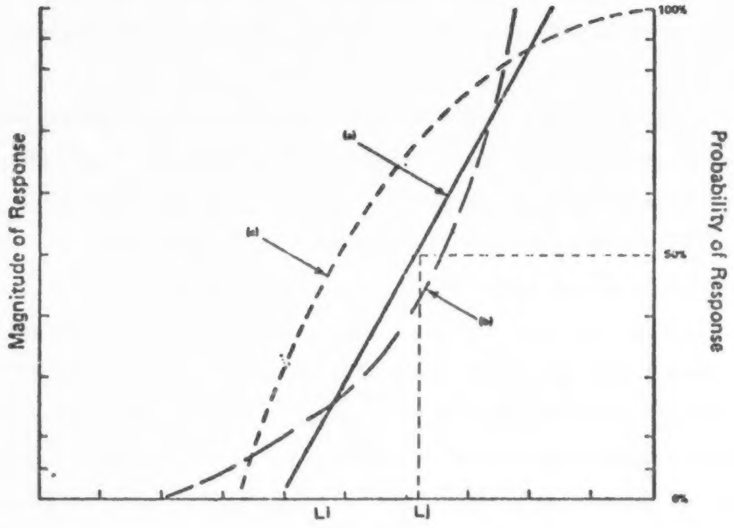

FIGURE 2 EXAMPLE OF FORMS OF NOISE EFFECTS CRITERIA: (a) Linear, (b) Power, (c) Logarithmic.

An environmental noise assessment usually involves analysis, evaluation and comparison of many different planning alternatives. Obviously, creating multiple arrays of population impact information is quite cumbersome, and subsequent comparisons between complex data tabulations generally tend to become somewhate subjective. What is clearly required is a single number of interpretation of noise environment which incorporates both attributes of extensity and intensity of impact. Accordingly, the National Academy of Sciences, Committee on Bioacoustics and Biomechanics (CHABA) has recommended a procedure for assessing environmental noise impact which mathematically takes into account both extensity and intensity of impact (1). This procedure, the fractional impact method, computes total noise impact by simply counting the number of people exposed to noise at different levels and statistically weighting each person by the intensity of noise impact. The result is a single number value which represents the overall magnitude of the impact.

The purpose of the fractional impact analysis methods is to quantitatively define the impact of noise upon the population exposed. This, in turn, facilitates trade-off studies and comparisons of the impact between different projects or alternative solutions. To accomplish an objective comparative environmental analysis, the fractional impact method defines a series of "partial noise impacts" within a number of neighborhoods or groups, each of which is exposed to a different level of noise. The partial noise impact of each neighborhood is determined by multiplying the number of people residing within the neighborhood by the "fractional impact" of that neighborhood, i.e., the statistical probability or magnitude of an anticipated response as functionally derived from relevant noise effects criteria. The total community impact is then determined by simply summing the partial impacts of all neighborhoods (1).

It is quite possible, and in some cases very probably, that a large proportion of a noise impact may be found in subneighborhoods exposed to noise levels of only moderate value. Although people living in proximity to a noise source are generally more severely impacted than those people living further away, this does not imply that the latter should be totally excluded from an assessment where the purpose is to objectively and quantitatively evaluate the magnitude of a noise impact. People exposed to lower levels of noise may still experience an adverse impact, even though that impact may be small in magnitude. The fractional impact method considers the total impact upon all people exposed to noise recognizing that some individuals incur a significantly greater noise exposure than others. The procedure duly ascribes more importance to the more severely affected population.

As discussed previously, any procedure which evaluates the impact of noise upon people or the environment, as well as the health and behavioral consequences of noise exposure and resultant community reactions, must encompass two basic elements of that impact assessment. The impact of noise may be intensive (i.e., it may severely affect a few people) or extensive (i.e., it may affect a larger population less severely). Implicit in the fractionalization concept is that the magnitude of human response varies proportionately with the degree of noise exposure, i.e., the greater the exposure, the more significant the response. Another major assumption is that a moderate noise exposure for a large population has approximately the same noise impact upon the entire community as would a greater noise exposure upon a smaller number of people. Although this may be conceptually envisioned as a trade-off between the intensity and extensity of noise impact, it would be a misapplication of the procedure to disregard those persons severely impacted by noise in order to enhance the environment of a significantly larger number of people who are affected to a lesser extent. The fact remains, however, that exposing many people to noise of a lower level would have roughly the same impact as exposing a fewer number of people to a greater level of noise when considering the impact upon the community or population as a whole. Thus, information regarding the distribution of the population as a function of noise exposure should always be developed and presented in conjunction with use of the fractional impact method.

Because noise is an extremely pervasive pollutant, it may adversely affect people in a number of different ways. Certain effects are well documented. Noise can:

- cause damage to the ear resulting in permanent hearing loss.
- interfere with spoken communication.
- disrupt or prevent sleep.
- be a source of annoyance.

Other effects of noise are less well documented but may become increasingly important as more information is gathered. They include the nonauditory health aspects as well as performance and learning effects.

It is important to note, however, that quantitatively documented cause-effect relationships which functionally characterize any of these noise effects may be applied within a fractionalization procedure. The function for weighting the intensity of noise impact with respect to general adverse reaction (annoyance) is displayed in Figure 3 (1). The nonlinear weighting function is arbitrarily normalized to unity at $L_{dn} = 75$ dB. For convenience of calculation, the weighting function may be expressed as representing percentages of impact in accordance with the following equation:

$$W(L_{dn}) = \frac{[3.364 \times 10^{-6}]\ [10^{0.103\ L_{dn}}]}{[0.2]\ [10^{0.03\ L_{dn}}] + [1.43 \times 10^{-4}]\ [10^{0.08\ L_{dn}}]} \quad (1)$$

A simpler linear approximation that can be used with reasonable accuracy in cases where day-night average sound levels range between 55 and 80 dB is shown as the dashed line in Figure 3 and is defined as:

$$W(L_{dn}) = \begin{matrix} 0.05\ (L_{dn} - 55) \text{ for } L_{dn} \geq 55 \\ 0 \qquad \text{for } L_{dn} < 55 \end{matrix} \quad (2)$$

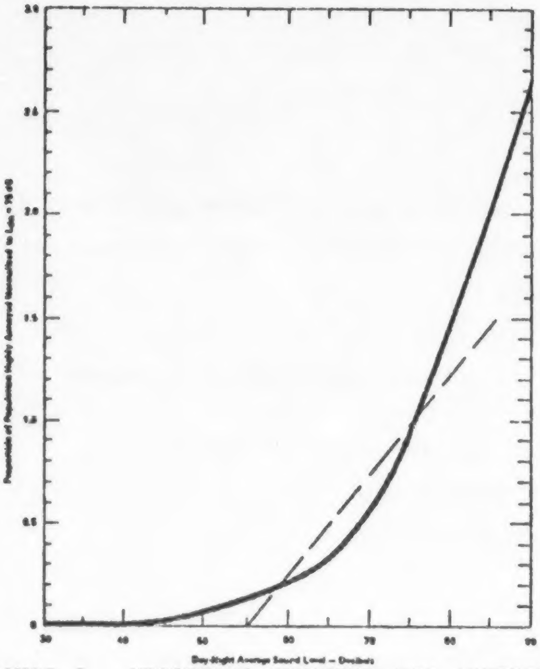

FIGURE 3. WEIGHTING FUNCTION FOR ASSESSING THE GENERAL ADVERSE RESPONSE TO NOISE

Using the fractional impact concept, an index referred to as the Equivalent Noise Impact (ENI)* may be derived by multiplying the number of people exposed to a given level of traffic noise by the fractional or weighted impact associated with that level as follows:

$$ENI_i = W(L_{dn}{}^i) \text{ X } P_i \qquad (3)$$

where ENI_i is the magnitude of the impact on the population exposed at $L_{dn}{}^i$, $W(L_{dn}{}^i)$ is the fractional weighting associated with a noise exposure of $L_{dn}{}^i$, and P_i is the number of people exposed to $L_{dn}{}^i$.

Because the extent of noise impact is characterized by a distribution of people all exposed to different levels of noise, the magnitude of the total impact may be computed by determining the partial impact at each level and summing over each of the levels. This may be expressed as:

$$ENI = \underset{i}{\ } ENI_i = \underset{i}{\ } W(L_{dn}{}^i) \text{ X } P_i \qquad (4)$$

---

* Terms such as Equivalent Population (P_{eq}), and Level-Weighted Population (LWP), have often been used interchangeably with ENI. The other indices are conceptually identical to the ENI notation.

The average severity of impact over the entire population may be derived from the Noise Impact Index (NII) as follows:

$$NII = \frac{ENI}{P_{total}} \qquad (5)$$

In this case, NII represents the percentage of the total population who describe themselves as highly annoyed. Another concept, the Relative Change in Impact (RCI) is useful for comparing the relative difference between two alternatives. This concept takes the form expressed as a percent change in impact:

$$RCI = \frac{ENI_i - ENI_j}{ENI_i} \qquad (6)$$

where ENI_i and ENI_j are the calculated impacts under two different conditions.

An example of the fractional impact calculation procedure is presented in Table 4.

Similarly, using relevant criteria, the fractional impact procedure may be utilized to calculate relative changes in hearing damage risk, sleep disruption, and speech interference.

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1. Guidelines for Preparing Environmental Impact Statements on Noise. National Academy of Sciences, Committee on Bioacoustics and Biomechanics Working Group Number 69, February 1977.

REFERENCES

(Adapted, in part, from Goldstein, J., "Assessing the Impact of Transportation Noise: Human Response Measures", Proceedings of the 1977 National Conference on Noise Control Engineering, G. C. Maling (ed.), NASA Langley Research Center, Hampton, Virginia, 17-19 October 1977, pp. 79-98.)

TABLE 4

EXAMPLE OF FRACTIONAL IMPACT CALCULATION FOR GENERAL ADVERSE RESPONSE

(1) Exposure Range (L_{dn})	(2) Exposure Range (L_{dn})	(3) P_i P_i	(4) $W(L_{dn})$ (Curvilinear)	(5) $W(L_{dn})$ (Linear approx.)	(6) ENI_i (Curvilinear) (Column (3) x (4))	(7) ENI_i (Linear) (Column (3) x (5))
55-60	57.5	1,200,000	0.173	0.125	207,600	150,000
60-65	62.5	900,000	0.314	0.375	282,600	337,500
65-70	67.5	200,000	0.528	0.625	105,600	125,000
70-75	72.5	50,000	0.822	0.875	41,100	43,750
75-80	77.5	10,000	1.202	1.125	12,020	11,250
		2,360,000			648,920	667,500

ENI (Curvilinera = 648,920

ENI (Linear) = 667,500

NII (Curvilinear) = 648,920 ÷ 2,360,000 = 0.27

NII (Linear) = 667,500 ÷ 2,360,000 = 0.28

APPENDIX N

RAIL CAR COUPLING NOISE MEASUREMENTS

1. Introduction

One of the major source of noise in railroad yards is the coupling of rail cars during routine classification operations. However, the data base on the noise levels generated during such operations is not very extensive -- particularly in terms of the effect of various parameters on the resulting noise level, such as the car-coupling speed, the types of cars involved in the coupling, their weights, whether they are loaded or unloaded, etc. For this reason, a limited series of experiments has been conducted to obtain measured noise levels during a variety of controlled car couplings.

The tests were conducted at the DARCOM Ammunitions Center in Savanna, Illinois, on 6 December 1978. The tests were designed primarily to investigate the effect of speed and car type and weight on the noise level generated during the car coupling. Noise levels were measured for six speeds between two and eight miles per hour, for each of five different configurations of rail cars.

This Appendix documents the results of these tests. In the next section the test procedure and measurements are provided and discussed in the third section.

2. Experimental Design

A total of 34 tests were conducted. Each test consisted of a single "test car" coupling with a string of one or more "buffer cars". For the first three sets of measurements, five empty box cars were used as the buffer cars; one empty box car, one fully-loaded box car, and one fully-loaded coal car were individually used as the test cars. For the next two sets of measurements, the fully-loaded coal car served as the buffer car, with one empty box car and one fully-loaded box car being used as the test cars. For these five configurations, tests were conducted for each of the following (nominal) speeds: 2, 3, 4, 5, 6 and 8 miles per hour.

The final configuration involved one empty box car coupling with four empty box cars at a nominal speed of 4 miles per hour. Four tests were conducted: one test with the buffer cars stretched apart so that there was no slack in any of the couplers; one test with the buffer cars pushed together for maximum coupler slack; and two tests with the buffer cars having random slack.

Each test proceeded as follows: The switch engine pushed the test car toward the buffer cars. When the engine and rail car had achieved the proper speed and were close enough to the buffer cars, the engine was braked, causing the test car to uncouple from it and proceed alone toward the buffer cars. Just before coupling with the buffer cars the speed of the test car was measured. As the test car coupled with the buffer cars, noise levels were measured at several locations nearby. After the test was concluded, the engine recoupled with the test car and pulled it and the attached buffer cars back so that the buffer cars were in their original position. The buffer cars were then uncoupled from the test car, and the engine and test car would retreat.

The speed of the test car immediately prior to coupling with the buffer cars was measured by timing the period between the closure of two switches located 11 feet apart on the track as the test car passed by the switches. These speed measurements were performed by the DARCOM Center staff and reported immediately after each test.

Noise data were collected at three locations (A, B, and C) as shown in Figure 1. At each of these locations for each test the noise was recorded on magnetic tape using the measurement instrumentation shown in Figure 2. In addition, at location A a sound level meter was

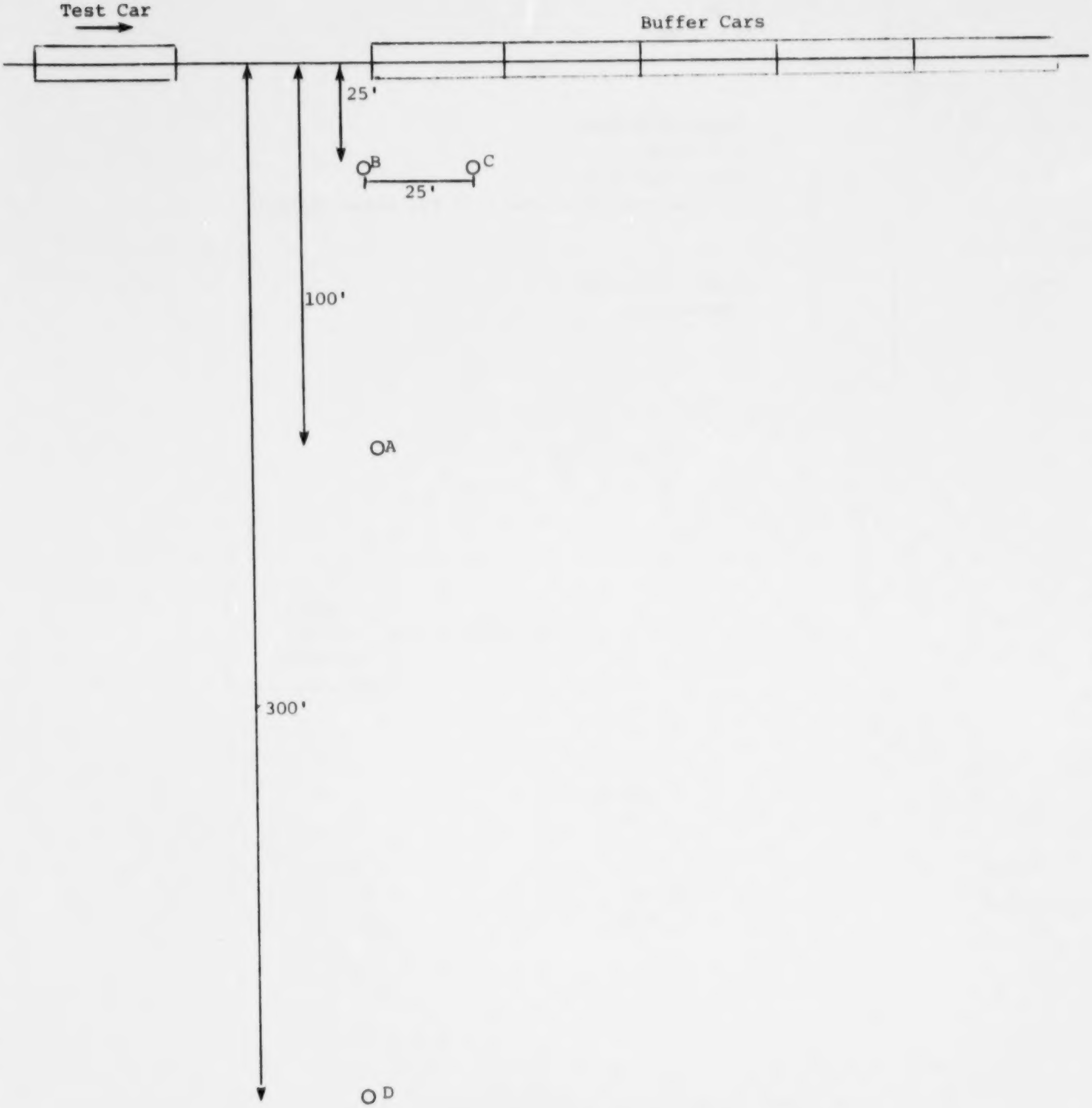

Figure 1. NOISE MEASUREMENT LOCATIONS

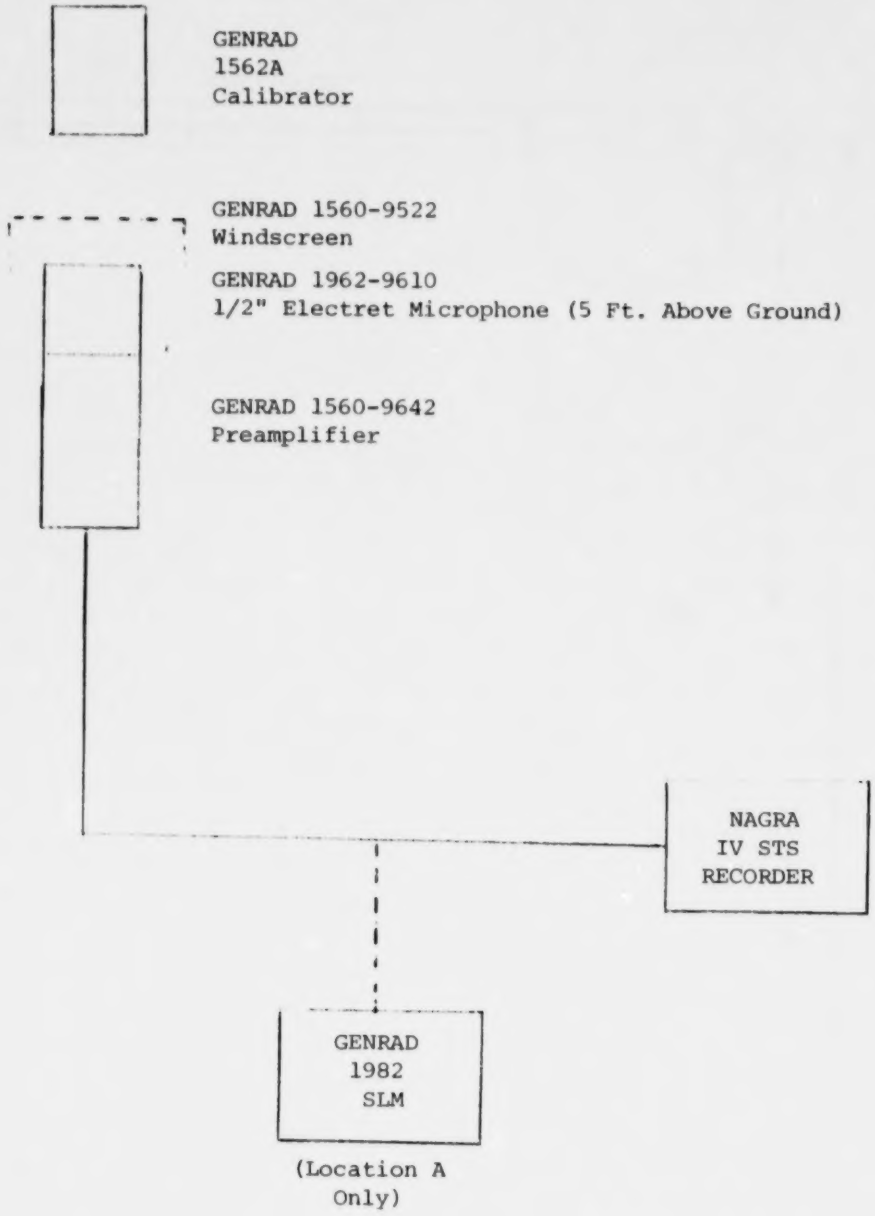

Figure 2. SCHEMATIC OF NOISE MEASUREMENT INSTRUMENTATION AT LOCATIONS A, B, AND C

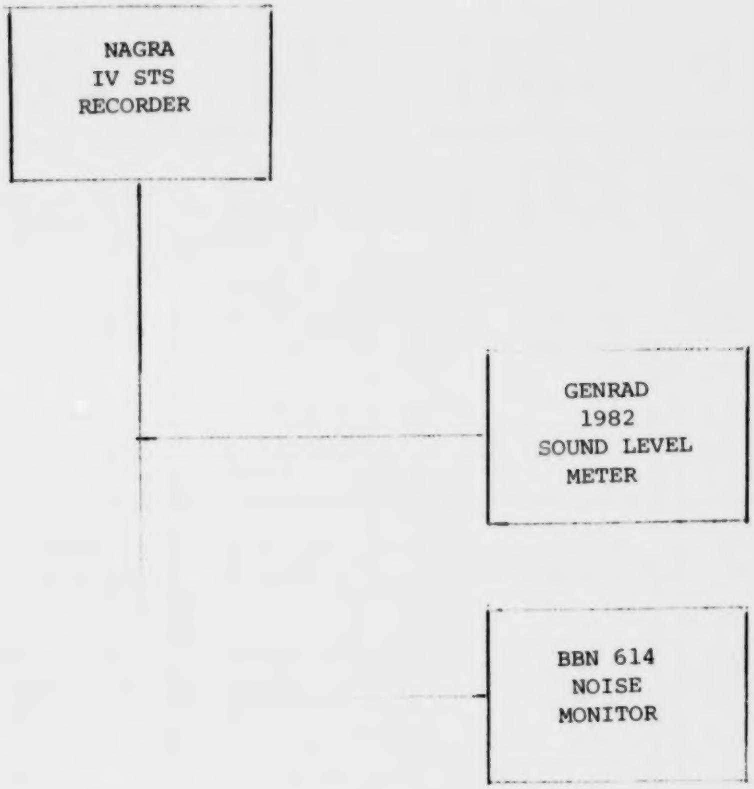

Figure 3. SCHEMATIC OF DATA PROCESSING INSTRUMENTATION

TABLE 1

MEASURED A-WEIGHTED NOISE LEVELS[1] DURING COUPLING TESTS

Test Number	Coupling Speed[2], mph	Position A			Position B			Position C			Position A	Position D[4]
		L_{max} Slow	L_{max} Fast	SEL	L_{max} Slow	L_{max} Fast	SEL	L_{max} Slow	L_{max} Fast	SEL	L_{max} Slow[3]	L_{max} Fast[3]
	ONE EMPTY BOX CAR COUPLING WITH FIVE EMPTY BOX CARS											
1	2.71	80.1	85.9	77.2	93.7	100.5	94.3	90.2	97.3	87.1	(80.6)[6]	68.3
2	3.17	80.3	86.0	77.0	94.2	102.1	94.8	90.2	97.9	87.7	80.7	70.2
3	3.93	85.1	92.9	86.0	98.4	108.0	98.2	95.2	104.3	95.6	85.6	74.9
4	5.38	(88.2)[5]	-	-	99.6	107.6	100.1	96.9	105.7	98.6	88.7	76.7
5	6.33	(90.4)[5]	-	-	101.9	110.1	102.3	98.9	107.7	100.3	90.9	81.0
6	8.21	(96.3)[5]	-	-	107.6	115.3	108.0	105.6	115.2	106.6	96.7	88.0
	ONE LOADED BOX CAR COUPLING WITH FIVE EMPTY BOX CARS											
7	2.35	80.9	88.7	78.3	91.7	101.5	92.4	90.6	101.3	88.1	80.4	72.0
8	3.28	84.2	90.7	85.5	95.6	103.9	95.8	94.6	103.7	95.0	85.1	75.0
9	4.40	89.1	95.9	94.0	99.1	107.3	99.7	98.0	106.5	99.7	(89.8)[6]	79.9
10	5.49	91.9	99.0	95.7	102.1	110.5	102.1	102.1	111.7	103.1	92.6	82.7
11	6.34	93.8	99.9	96.8	104.3	112.0	104.4	103.9	112.3	105.0	94.5	85.4
12	8.19	96.1	102.8	98.5	106.9	114.3	106.6	106.3	114.9	106.6	96.0	87.4
	ONE LOADED COAL CAR COUPLING WITH FIVE EMPTY BOX CARS											
13	2.11	81.6	88.1	81.1	93.4	101.4	93.0	90.3	101.5	87.9	82.0	73.4
14	2.87	85.2	92.0	86.2	95.3	103.8	95.4	95.1	104.5	96.0	85.7	75.3
15	4.00	90.3	96.9	92.2	100.1	107.5	101.6	99.6	108.9	100.8	90.1	81.3
16	5.18	92.5	99.2	94.5	103.0	111.5	103.6	102.6	112.7	103.6	93.1	82.4
17	6.48	95.6	102.3	97.1	106.4	114.3	106.5	105.8	115.9	106.1	96.1	87.3
18	8.33	99.5	105.7	103.1	109.7	117.1	104.6	110.2	119.5	110.4	98.8	89.6

TABLE 1 (Continued)

Test Number	Coupling Speed[2] mph	Position A			Position B			Position C			Position A	D[4]
		L_{max} Slow	L_{max} Fast	SEL	L_{max} Slow	L_{max} Fast	SEL	L_{max} Slow	L_{max} Fast	SEL	L_{max} Slow[3]	L_{max} Fast[3]
ONE EMPTY BOX CAR COUPLING WITH ONE LOADED COAL CAR												
19	2.30	82.0	88.9	82.0	95.7	102.3	96.0	90.3	100.4	89.9	83.1	73.2
20	3.06	(83.5)[5]	-	-	96.0	104.5	96.0	90.7	100.4	90.3	83.9	75.7
21	4.24	86.8	95.3	88.2	99.6	108.7	99.9	94.7	104.8	95.5	87.3	79.0
22	5.11	88.3	95.2	89.9	101.7	110.7	102.7	96.1	105.2	97.8	88.1	78.7
23A	-	91.8	99.2	94.2	104.5	112.0	105.1	99.3	108.1	100.2	91.9	83.2
23B	6.34	91.8	99.3	94.4	104.7	114.2	105.1	100.0	112.2	100.8	91.9	83.0
24	8.04	96.3	102.5	98.3	107.7	114.5	108.1	102.4	111.9	103.2	96.1	86.1
ONE LOADED BOX CAR COUPLING WITH ONE LOADED COAL CAR												
25	2.01	79.2	89.2	76.4	92.3	102.5	90.9	87.5	100.6	91.2	78.7	68.5
26	3.07	84.7	92.4	86.1	97.7	106.6	97.1	92.0	101.0	92.0	84.7	74.7
27	4.04	87.0	94.5	89.1	98.7	107.0	99.1	94.2	104.4	95.0	86.5	76.2
28	5.08	93.1	102.5	95.1	106.5	117.9	105.1	100.5	112.8	100.0	92.8	80.4
29	6.14	94.6	103.6	96.3	107.1	117.1	106.3	101.6	113.6	101.3	94.4	83.6
30	8.17	96.4	105.2	98.5	107.9	118.2	-	102.3	114.4	102.1	96.3	85.0
ONE EMPTY BOX CAR COUPLING WITH FOUR EMPTY BOX CARS												
31	4.11	87.4	94.6	89.5	98.9	106.3	99.7	95.2	103.7	96.3	86.9	77.2
32	4.04	86.1	93.8	88.2	99.0	106.2	99.9	94.8	103.3	95.9	86.1	76.8
33	4.15	88.8	97.3	91.0	99.8	106.2	100.6	96.5	104.8	97.8	88.8	79.7
34	3.91	87.5	94.3	89.5	98.8	105.9	99.5	96.1	104.7	97.2	87.6	76.7

1. All noise levels are in units of dBA.
2. Coupling speeds were measured by DARCOM Center staff.
3. Noise levels in last two columns were read directly in the field; all other levels were determined from recordings.
4. Noise levels at Position D were masured by EPA Regional staff.
5. These noise levels were estimated from the levels read directly in the field.
6. These noise levels were estimated from the recorded noise data.

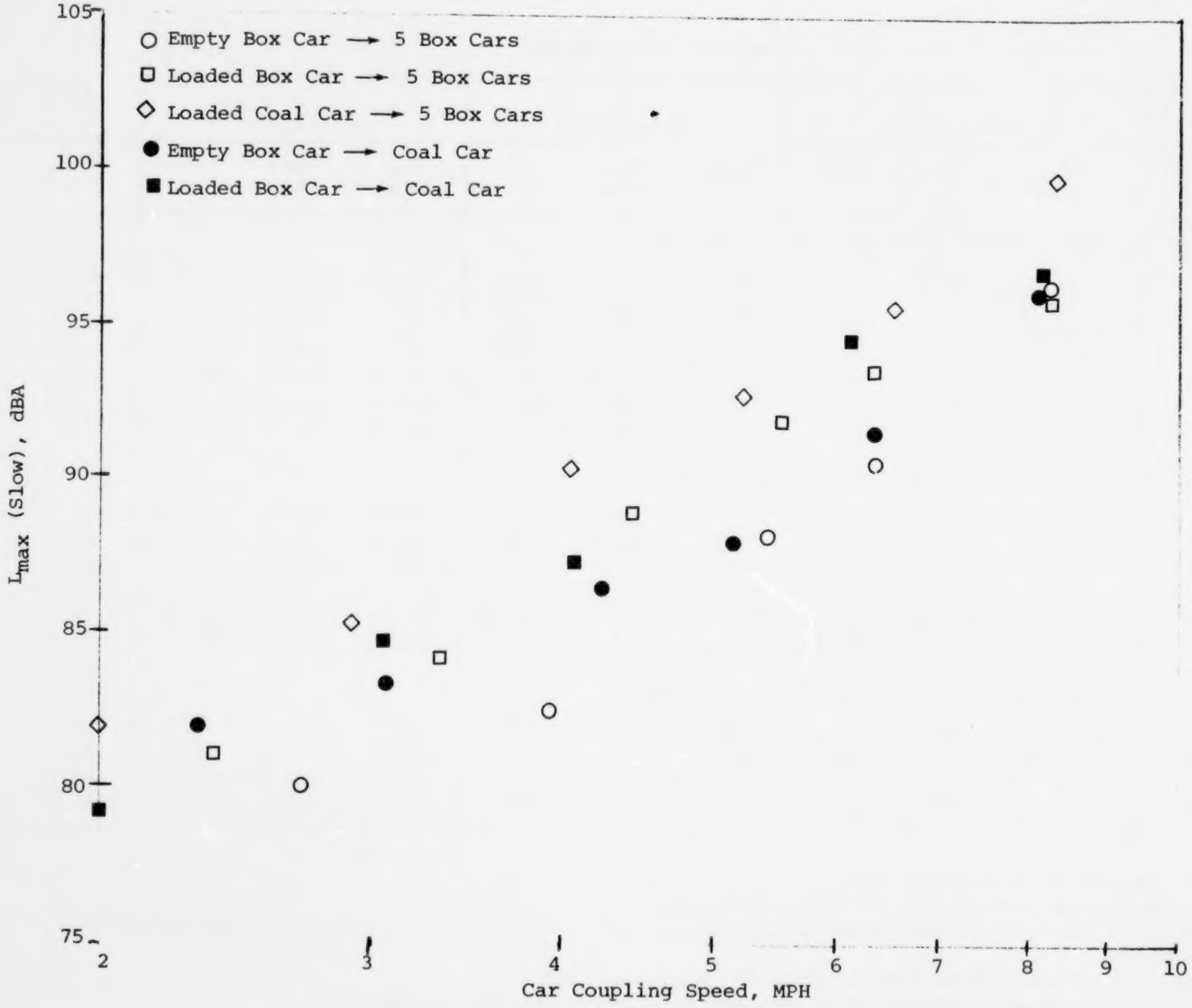

Figure 4. MAXIMUM NOISE LEVELS VS. SPEED (Slow Meter Dynamics)

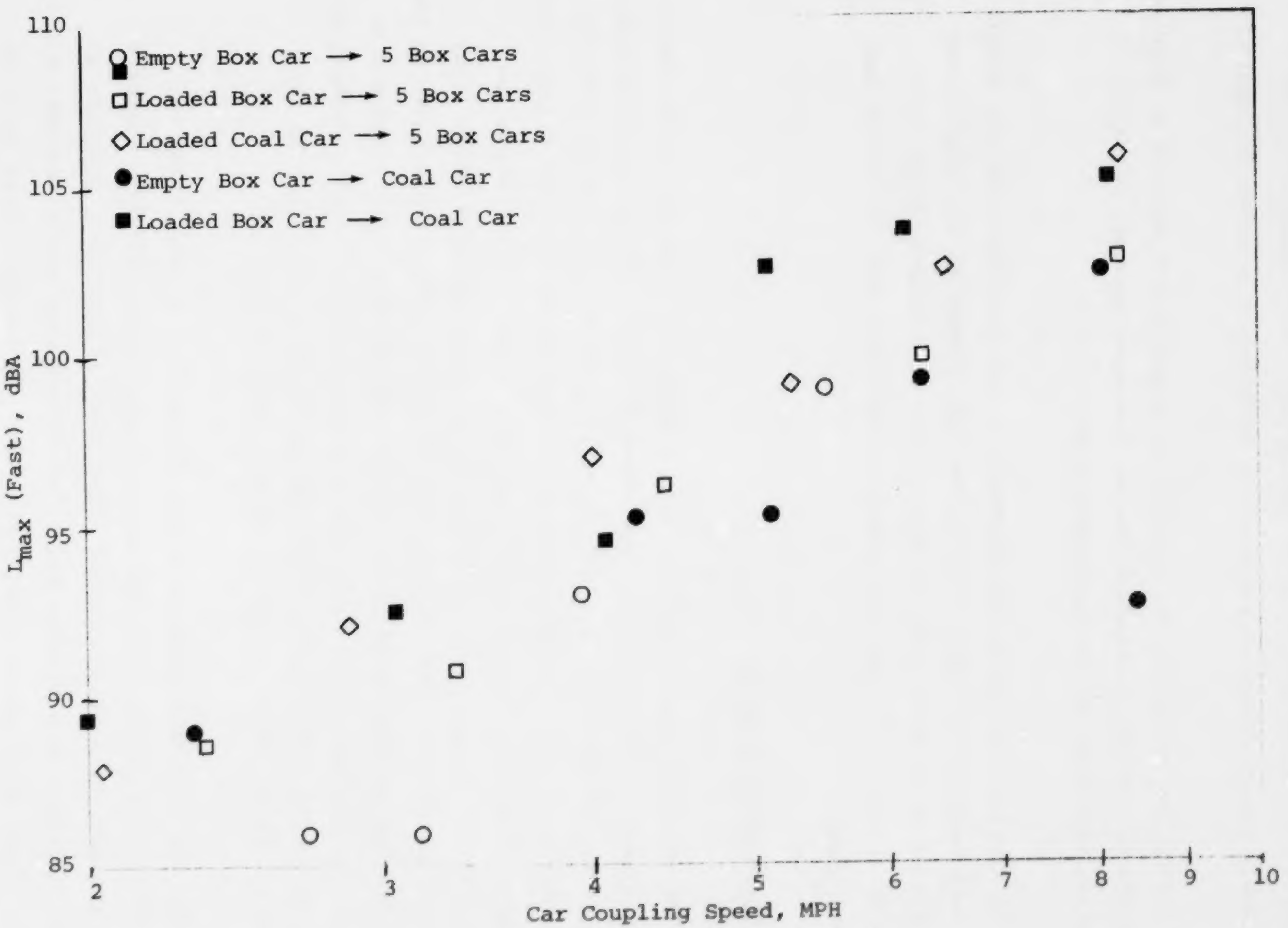

Figure 5. MAXIMUM NOISE LEVELS VS SPEED (Fast Meter Dynamics)

included to provide a direct reading of the maximum level occurring during the test. Two additional sets of measurements were obtained by EPA personnel, one at location B and one at location D as shown in Figure 1.

During the measurements, calibration signals were applied at regular intervals to provide a standard for the measured data and to check the operating stability of the instrumentation.

At regular intervals, the temperature and wind direction and magnitude were measured as well. During the day of testing the temperature varied from 19 to 22°F, and the wind varied from calm to 8 mph (with gusts to 12 mph). The sky was generally overcast, and the ground was snow-covered.

3. Measurement Results

The recorded noise levels at each measurement location (A, B, and C) were played back into a sound level meter to obtain the maximum A-weighted sound level for both slow and fast dynamic response and into an integrating sound level meter to obtain the sound exposure level (see Figure 3 for a diagram of the playback instrumentation). Table 1 lists these two maximum values (L_{max} slow and fast) and the sound exposure level (SEL) for each measurement location for each of the 34 tests. Also shown on the table are the maximum levels read directly in the field at location A as well as the maximum levels read directly in the field by EPA personnel at location D. The car-coupling speed measured during each test by the DARCOM Center personnel is listed on the table as well.

For the five test configurations for which the noise level was mesured at each of six different speeds (tests 1 through 30), Figure 4 shows the maximum A-weighted slow noise level plotted as a function of speed. Figure 5 is a similar plot, for the maximum A-weighted fast noise level. These two figures clearly show that the maximum noise level is a strong function of car-coupling speed. The maximum level can be expressed as a function of speed, V, as follows:

$L_{max} = A + B \log V,$

where the quantities "A" and "B" are constants. "B", the slope of the line through the data points, is on the order of 30 for both Figures 4 and 5. "A" will vary with the car configuration.

For the first three configurations in which different test cars coupled with five empty box cars, the maximum noise level at any speed appears to increase with the weight of the test car (Table 2 lists the weights of all test and buffer cars used during the measurements). For the two configurations with the loaded coal car as the buffer car, the noise levels for several tests are near the levels measured when the buffer cars are the five empty box cars (particularly for the slow data). Since the weight of the loaded coal car is nearly identical to the weight of the five empty box cars, the noise level appears to be more a function of weight than of buffer car type or configuration. The highest overall noise levels generally occurred when the loaded coal car coupled with the five empty box cars.

Even though the variation of level with car weight can be seen from the data in Figures 4 and 5, the actual range in levels at any given speed is not very large: 5 to 7 dB at the lower speeds and 2 to 4 dB at the upper speeds. This implies that for other configurations with different cars than those measured under these tests, if the weights are comparable the noise levels will probably lie within the same general range.

By examining the average value of the differences between two sets of data, and the associated standard deviation about that average, conclusions can be drawn concerning the relationships between the two data sets. Table 3 lists such averages and standard deviations for a variety of sets of data. First, differences between the levels measured at locations B and C are examined. The noise levels (slow) at location C are consistently lower than at location B, with an average difference of more than 3 dB. This implies that the maximum noise during the coupling activity is generated at the coupler itself, and not from any secondary radiation from the car body.

Comparison of the 100 and 300 foot slow noise data shows an average difference of 9.8 dB. For a point source, one would expect a change in level of 9.5 dB between measurement positions located 100 and 300 feet from the source. This is indeed shown to be the case for car-coupling noise.

Comparison of the maximum levels determined using fast versus slow dynamic response of the sound level meter shows an average difference of 8.5 dB. Based upon the fast and slow dynamics, this implies that the car-coupling noise has a typical duration on the order of 1/10 of a second. The small standard deviation (1.5 dB) also implies that one can estimate the slow level from measurement of the fast, and vice versa, with reasonable accuracy.

Similarly, the small standard deviation in the difference between the SEL values and slow max levels also indicates that estimates of one quantity based upon measurements of the second can be made with reasonable accuracy. This is of particular interest since measurement of the maximum level is generally less costly to obtain than measurement of the SEL value. Estimation of the SEL can also be based on measurement of the fast max levels, but with somewhat lower accuracy (since the standard deviation is higher).

With regard to the last four measurements (tests 31 through 34), Table 1 shows that there is minimal difference in the noise level generated when the buffer cars are compressed versus stretched versus randomly positioned. Although the number of measurements is in reality too small to draw statistically significant conclusions, the condition of the buffer cars with regard to being stretched or compressed does not appear to be an important variable in influencing the coupling noise level.

Comparison of the maximum levels measured at location B for the last four tests, all conducted at the same nominal speed, indicates that there is a rather small variability (1 dB) in repeat runs of the same (or nearly the same) configuration. At location A the variability is somewhat higher; this may be due to meteorological effects which would be more pronounced as the distance from the source to the microphone increases.

TABLE 2
WEIGHT OF RAIL CARS USED IN TESTS

CAR(S)	WEIGHT, POUNDS
Empty Box Car	44,100
Loaded Box Car	140,774
Loaded Coal Car	220,000
5 Empty Box Cars	227,900
4 Empty Box Cars	184,000

TABLE 3
ANALYSIS OF DIFFERENCES BETWEEN SETS OF CAR COUPLING NOISE LEVELS

DATA SETS	AVERAGE DIFFERENCE, dB	STANDARD DEVIATION, dB	NO. OF SAMPLES
L_{max} at Location B - L_{max} at Location C (slow)	3.1	2.1	35
L_{max} at Location A - L_{max} at Location D (slow)	9.8	1.1	35
L_{max} Fast - L_{max} Slow	8.5	1.5	101
L_{max} Slow - SEL	- 0.6	1.6	100
L_{max} Fast - SEL	7.9	2.4	100

REFERENCES

1. Bolt Beranek and Newman, Inc.; Report No. 3873, 1978, Cambridge, Massachusetts.

APPENDIX O

U. S. COURT OF APPEALS DECISION

Notice: This opinion is subject to formal revision before publication in the Federal Reporter or U.S.App.D.C. Reports. Users are requested to notify the Clerk of any formal errors in order that corrections may be made before the bound volumes go to press.

United States Court of Appeals

FOR THE DISTRICT OF COLUMBIA CIRCUIT

No. 76-1353

ASSOCIATION OF AMERICAN RAILROADS, CHESAPEAKE AND OHIO RAILWAY COMPANY, CHICAGO AND NORTH WESTERN TRANSPORTATION COMPANY, AND SOUTHERN RAILWAY COMPANY, PETITIONERS

v.

DOUGLAS M. COSTLE, ADMINISTRATOR OF THE ENVIRONMENTAL PROTECTION AGENCY AND THE ENVIRONMENTAL PROTECTION AGENCY, RESPONDENTS

THE STATE OF ILLINOIS, INTERVENOR

Petition for Review of an Order of the Environmental Protection Agency

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Argued 7 June 1977

Decided 23 August 1977

Judgment entered this date ←

Bills of costs must be filed within 14 days after entry of judgment. The court looks with disfavor upon motions to file bills of costs out of time.

Richard J. Flynn, with whom *Lee A. Monroe* and *Joseph B. Tompkins, Jr.*, were on the brief, for petitioners.

Erica L. Dolgin, Attorney, Department of Justice, with whom *Peter R. Taft*, Assistant Attorney General and *Jeffrey O. Cerar*, Attorney, Environmental Protection Agency, were on the brief, for respondents.

Russell R. Eggert was on the brief for intervenor.

Before TAMM and WILKEY, *Circuit Judges*, and WILLIAM B. JONES,* *United States Senior District Judge* for the United States District Court for the District of Columbia

Opinion for the Court filed by *Circuit Judge* WILKEY.

WILKEY, *Circuit Judge*: In this petition for review,[1] the Association of American Railroads[2] (AAR) challenges the validity of the action of the Administrator of the Environmental Protection Agency (EPA) in promulgating Railroad Noise Emission Standards limited to rail cars and locomotives operated by surface carriers engaged in interstate commerce by railroad.[3] These regulations were promulgated pursuant to Section 17 of the Noise Control Act of 1972 (the Act) which requires the Administrator to establish emission standards for noise "resulting from operation of the equipment and facilities" of interstate rail carriers.[4] The petitioner does not challenge the validity of the noise emission standards set for rail cars and locomotives; rather, the AAR contends that the Administrator has interpreted the mandate embodied in Section 17 of the Act unlawfully in failing to establish standards for *all* of the "equipment and facilities" of interstate rail carriers. The EPA, on the other hand, argues that the Act vests the Administrator with discretion to determine which sources of railroad noise are to be regulated at the federal level.

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* Sitting by designation pursuant to Title 28, U.S.C. § 294 (c).

[1] This petition for review is properly before the court pursuant to 42 U.S.C. § 4915.

[2] The State of Illinois was allowed to intervene as a party respondent by order of this court on 18 May 1976.

[3] The regulations are stated at 40 C.F.R. §§ 201.11, 201.12, 201.13.

[4] 42 U.S.C. § 4916.

After carefully reviewing the language of the Noise Control Act and its legislative history, we conclude that the EPA has misinterpreted the scope of the mandate embodied in Section 17 of the Act through its artificially narrow definition of "equipment and facilities." Accordingly, we reverse the decision of the Administrator to limit the scope of the Railroad Noise Emission Standards and remand the case to the EPA with directions to promulgate noise emission standards in a manner not inconsistent with this opinion.

I. STATUTORY FRAMEWORK

The requirements for the regulation of railroad noise are contained in Section 17 of the Act. In pertinent part, this Section of the Act provides that:[3]

> (a) (1) Within nine months after October 27, 1972, the Administrator shall publish proposed noise emission regulations for surface carriers engaged in interstate commerce by railroad. Such proposed regulations shall include noise emission standards setting such limits on noise emissions resulting from operation of the equipment and facilities of surface carriers engaged in interstate commerce by railroad which reflect the degree of noise reduction achievable through the application of the best available technology, taking into account the cost of

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[3] *Id.*

> compliance. These regulations shall be in addition to any regulations that may be proposed under section 4905 of this title.
>
> (2) Within ninety days after the publication of such regulations as may be proposed under paragraph (1) of this subsection, and subject to the provisions of section 4915 of this title, the Administrator shall promulgate final regulations. Such regulations may be revised, from time to time, in accordance with this subsection.
>
> * * * *
>
> (c) (1) Subject to paragraph (2) but notwithstanding any other provision of this chapter after the effective date of a regulation under this section applicable to noise emissions resulting from the operation of any equipment or facility of a surface carrier engaged in interstate commerce by railroad, no State or political subdivision thereby may adopt or enforce any standard applicable to noise emissions resulting from the operation of the same equipment or facility of such carrier unless such standard is identical tc a standard applicable to noise emissions resulting from such operation prescribed by any regulation under this section.
>
> (2) Nothing in this section shall diminish or enhance the rights of any State or political subdivision thereof to establish and enforce standards or controls on levels of environmental noise, or to control, license, regulate, or restrict the use, operation, or movement of any product if the Administrator, after consultation with the Secretary of Transportation determines that such standard, control, license, regulation, or restriction is necessitated by special local conditions and is not in conflict with regulations promulgated under the section.

There are three points concerning the language of Section 17 which deserve mention at this point; an examination of these three points will serve to focus the analysis on the precise issue that forms the basis of the controversy in this case. There is a particularly strong need in this case to focus the discussion at an early stage since the parties, both in their briefs and at oral argument, have devoted much attention to issues which are either beyond peradventure or are not germane to the case in its present posture.[6]

First of all, it is clear from the language of Section 17(a)(1) and (2) that the Administrator is under a mandatory duty to establish noise emission standards for interstate rail carriers. The word "shall" is the language of command in a statute,[7] and there is no doubt that the Congress has commanded the Administrator of the EPA to promulgate railroad noise emission standards. In Section 17(a)(1), however, Congress went beyond commanding the Administrator to establish standards and sought to specify the subject matter to be regulated. In so specifying the subject matter, Congress also used the language of command—the regulations "*shall include*" standards setting limits on noise emanating from "the equipment and facilities" of interstate rail carriers.[8] In this sentence the phrase "shall include" refers to and incorporates the phrase "equipment and facilities" as the subject matter which *must* be included in the mandatory regulations. Thus, *both* the obligation to promulgate regulations and the subject matter to be regulated are dictated by the statute. Although there is a mandatory duty relative to "equipment and facilities," the statute does not attempt to define the phrase "equipment and facilities" beyond the use of the words themselves.

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[6] For example, the petitioner devotes substantial energy to the question of whether the Act has preemptive effect. *See* Brief of Petitioners at 9-32. The Act clearly has such an effect; *see* text at notes 10, 35, and 36, *infra*.

The respondents focus on the issue of whether the EPA has exercised its discretion in a reasonable manner; *see* Brief for Respondents 26-37. The discussion by respondents assumes that discretion is vested in the EPA; we have concluded that it does not and, therefore, this discussion of the reasonableness of the exercise of discretion is not relevant.

[7] *See, e.g., Boyden* v. *Comm. of Patents*, 441 F.2d 1041 (D.C. Cir. 1971).

[8] 42 U.S.C. § 4916(a)(1).

Given this strong mandatory language in the statute, we can brush aside subsidiary and diversionary issues to formulate the issue under review in this case as simply: with respect to the subject matter to be regulated, what is the scope of the Administrator's mandatory duty?[9]

The second point to be made concerning the language of Section 17 deals with the issue of preemption. It is clear that, under the Supremacy Clause of the Constitution, federal law can preempt state law in a particular subject area.[10] Congressional intent to preempt state and local regulation must at times be inferred from the overall structure of regulation found in the federal statute; such a need to infer is not present in this case. Section 17(c)(1) of the Act constitutes an explicit and direct preemption clause. Under the terms of this subsection, noise emission regulations relative to "the operation of any equipment or facility" of an interstate rail carrier will preempt state or local regulations dealing with the same sources of noise. In addition, the scope of the preemption provision appears clear; all regulations promulgated pursuant to Section 17(a)(1) and (2) are to have preemptive effect. That is, if a regulation comes within the scope of the mandatory duty specified in Section 17(a)(1) and (2), the regulation then displaces inconsistent state or local laws.

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[9] We emphasize that the question as to the *degree* of regulation to be applied to various noise sources is not before us in this case. The sole issue which we address concerns the question as to *what* is to be regulated.

[10] *See, e.g., Florida Lime & Avocado Growers, Inc.* v. *Paul*, 373 U.S. 132 (1963).

Thus, the existence and scope of federal preemption are not directly at issue in this case; the former is beyond doubt, while the latter is dictated by the scope of the mandatory duty to establish standards (which is the focus of this case).

The third and final point to be made concerning the language of Section 17 at this time concerns the provision for local variances under Section 17(c)(2) of the Act. Under this provision the Administrator may, after consultation with the Secretary of Transportation, allow states or localities to establish and enforce standards if such standards are "necessitated by special local conditions and [are] not in conflict with regulations promulgated under this section."[11] This provision for local variances has no effect on the scope of the mandatory duty outlined in Section 17(a), nor does it alter the preemption provisions of Section 17(c)(1); in fact, the nature of this provision would seem to confirm preemption. Section 17(c)(2) performs a valuable function in its recognition that local conditions may dictate some degree of flexibility in the approach to noise control. The provision does not, however, limit the scope of the Administrator's mandatory duty or the preemptive effect of the regulations issued pursuant to that duty.

In summary, by virtue of the language and structure of Section 17 of the Act, the relevant question for purposes of this analysis concerns the scope of the mandatory duty to regulate railroad noise. In particular, this scope is to be defined by reference to the phrase "equipment and facilities" in Section 17. Before turning to an exposition of what we believe to have been the Congressional intent behind this phrase, we shall examine the definition provided by the Administrator during the course of the rulemaking proceedings here under review.

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[11] 42 U.S.C. § 4916(c)(2).

II. PROCEDURAL BACKGROUND

The first formal step taken by EPA to implement Section 17 was the issuance of an advance notice of proposed rulemaking, which announced EPA's intent to develop regulations and invited the participation of all interested parties.[12] The comment period was subsequently extended to 1 June 1973.[13] On 3 July 1974 EPA issued a notice of proposed rulemaking in which the agency announced its intention to regulate rail cars and locomotives but not other railroad equipment or facilities.[14] The Administrator provided the following rationale for so limiting the regulations: [15]

> Many railroad noise problems can best be controlled by measures which do not require national uniformity of treatment to facilitate interstate commerce at this time. The network of railroad operations is imbedded into every corner of this country, including rights-of-way, spurs, stations, terminals, sidings, marshaling yards, maintenance shops, etc. Protection of the environment for such a complex and pervasive industry is not simply a problem of modifying noisy equipment, but get down into the minutiae of countless daily railroad operations at thousands of locations across the country. The environmental impact of a given railroad operation will vary depending on whether it takes place, for example, in a desert or adjacent to a residential area. For this reason, EPA

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[12] 38 Fed. Reg. 3086.

[13] 38 Fed. Reg. 10644.

[14] 39 Fed. Reg. 24580.

[15] *Id.* at 24580-81.

believes that State and local authorities are better suited than the Federal government to consider fine details such as the addition of sound insulation or noise barriers to particular facilities, or the location of noisy railroad equipment within those facilities as far as possible from noise-sensitive areas, etc. There is no indication, at present, that differences in requirements for such measures from place to place impose any significant burden upon interstate commerce. *At this time*, therefore, it appears that national uniformity of treatment of such measures is not needed to facilitate interstate commerce and would not be in the best interest of environmental protection.

The national effort to control noise has only just begun, however, and it is inevitable that some presently unknown problems will come to light as the effort progresses. Experience may teach that there are better approaches to some aspects of the problem than those which now appear most desirable. The situation may change so as to call for a different approach. Section 17 of the Noise Control Act clearly gives the Administrator of the Environmental Protection Agency authority to set noise emission standards on the operation of all types of equipment and facilities of interstate railroads. If in the future it appears that a different approach is called for, either in regulating more equipment and facilities, or fewer, or regulating them in a different way or with different standards consistent with the criteria set forth in Section 17, these regulations will be revised accordingly.

After publication of the proposed regulations, EPA made available a detailed "Background Document" for the regulations; this document is significant for the candor and frankness with which it explains the agency's decision to limit its regulation.[16] After this, a public hearing was held and further written comments were solicited and received.[17] The AAR submitted written comments on 27 August 1974 in which the organization put forth the same arguments being pursued in this appeal.[18] The EPA rejected these arguments and published the final, but limited, regulations on 14 January 1976. This petition for review of the final regulations was then timely filed on 14 April 1976.[19]

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[16] The document is reproduced in the Joint Appendix (J.A.) at 28-31. *See also* text and notes at notes 45 to 48, *infra*.

There are two major themes in the EPA's justification for limiting its regulation which should be identified at this point. The first concerns the issue of timing; EPA has repeatedly stated that it is limiting the subject matter of its noise standards "at this time." The agency has during the course of its administrative proceedings specifically reserved the option to regulate all aspects of railroads "equipment and facilities" in the future.

The second theme is related to the first; while declining to regulate additional equipment and facilities at this time, the Administrator explicitly or impliedly encouraged state and local jurisdictions to adopt noise emission standards for some types of equipment and facilities. As EPA stated,[20]

> "Although the EPA does not currently propose to regulate retarder noise, it does recommend that local jurisdictions establish regulations which require railroads to utilize barrier technology where needed and where both practical and feasible . . .
>
> "They [local and state jurisdictions] may adopt and enforce noise emission standards on other pieces of equipment not covered by EPA regulations, such as retarders and railroad construction equipment . . .

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[17] 39 Fed. Reg. 24585.

[18] J.A. at 117-160.

[19] *See* 42 U.S.C. § 4915.

[20] *See* J.A. at 18, 24-25.

> "State and local governments may enact noise emission standards for facilities which EPA has not regulated. However, . . . where federally regulated equipment is a noise contributor in a facility on which a State or local government proposes to set a noise emission standard, such as a marshalling yard, such regulation may or may not be preempted . . .
>
> ". . . EPA believes that design or equipment standards on federally regulated equipment—viz., locomotive and rail cars—are preempted. Design or equipment standards on other pieces of equipment such as retarders or cribbing machines, are not preempted. Similarly, design standards on facilities not federally regulated are not preempted, even though locomotives and rail cars may operate there, because they do not require the modification of locomotives or rail cars. An example of this type of regulation would be a local ordinance requiring that noise barriers be installed along the rights of way running through that community."

Thus, although EPA recognized the need for additional regulation, the agency did not take it upon itself to meet this need through EPA-sponsored regulations. In addition, the encouragement of local regulation was subject to the EPA's reservation of power to regulate in those same areas in the future. This facet of the agency's position will assume a prominent role in our analysis in Part III, *infra.*

In summary, the administrative process described above resulted in standards regulating noise from only three sources: 1) locomotive operation under stationary conditions;[21] 2) locomotive operation under moving conditions;[22] and 3) rail car operations.[23] No other types of railroad equipment and no railroad facilities *at all* are within the coverage of the promulgated standards. Specifically, the following "equipment and facilities" are excluded from federal regulation: horns, bells, whistles and other warning devices; respair and maintenance shops, terminals, marshalling yards, and rail car retarders; special purpose equipment, such as cranes, derricks, and other types of maintenance-of-way equipment; and track and rights-of-way.[24] The propriety of excluding these sources of noise from regulation in light of the statutory mandate in Section 17(a) of the Act will now be examined.

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[21] 40 C.F.R. § 201.11.

[22] *Id.* at § 201.12.

[23] *Id.* at § 201.13.

III. ANALYSIS

A. *Statutory Language*

1. *Section 17(a)(1).* The starting point for an analysis of the scope of the subject matter to be regulated pursuant to the Administrator's mandatory duty to publish noise emission regulations must be the language of Section 17(a)(1). As noted previously, "shall include" refers to "the equipment and facilities" in this context;[25] the definition of the latter phrase dictates the scope of the mandatory subject matter. We believe that the reference to "*the* equipment and facilities" is unambiguous. The plain meaning of this phrase yields a definition that would, in the absence of any contradictory evidence, subsume *all* such equipment and facilities. There is absolutely no indication in Section 17(a)(1) that Congress intended to vest discretion in the EPA to decide *which*

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[24] This listing is not meant to be an exhaustive compilation of the subject matter included within the phrase "equipment and facilities." The definition of this term must be made by the agency with a realistic reference to the definition of the term customarily employed in the railroad industry. *See* text and notes at notes 45 to 48, *infra.*

[25] *See* text and notes at notes 7 to 8, *supra.*

of *the* equipment and facilities would be subject to regulation. Nothing in the statute diminishes or qualifies the generality of these two key words—*equipment* and *facility*. Nothing in the statute states that only certain kinds of equipment or facilities need to be regulated. The plain and natural meaning of the phrase "the equipment and facilities" is that the power of the EPA is plenary with respect to those objects and places customarily thought to be included in the definition of the phrase. To read this language otherwise would be to distort a relatively clear signal from the national legislature. Indeed, in the context of this case, the EPA chose not to regulate any "facilities" at all; this action in effect reads this word out of the statute. We are not prepared to label this word as being superfluous to the statutory mandate.[26]

The EPA presents only one argument with respect to the statutory language in Section 17(a)(1). The agency contends that "[i]f Congress had meant to require EPA to regulate *all* equipment and facilities it could easily have said so by using the word 'all' rather than the word 'the.'"[27] This is perhaps the weakest of all statutory construction arguments, particularly where, as here, the proponent of the argument puts forth alternative language which Congress should have used which has substantially the same meaning as the language which Congress did employ. The principle being contended for by the EPA with respect to the language of Section 17(a)(1) has no limits; it is the last refuge for those who find themselves in the unenviable position of having to argue against the plain meaning of statutory language. Although EPA can draw no support from the language of Section 17(a)(1), the agency seeks to establish the existence of discretion to choose among various equipment and facilities by reference to the language of the preamble of the Act.[28]

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[26] Of course, the EPA has reserved the option to regulate "facilities" in the future (see note 15, *supra*). The EPA thus believes that it can choose the timing of its regulations, a proposition with which we disagree. *See* text and notes at notes 49 to 50, *infra*.

[27] Brief for Respondents at 10.

2. *The Preamble.* The EPA makes much of the fact that the preamble to the Act states that

> while primary responsibility for control of noise rests with State and local governments, Federal action is essential to deal with *major* noise sources in commerce control of which require national uniformity of treatment.[29]

EPA would have us read this language as if it said that the Federal government can regulate *only* "major noise sources."

The EPA argument based on the language in the preamble is based on an erroneous perception of the operation and significance of such language. A preamble no doubt contributes to a general understanding of a statute, but it is not an operative part of the statute and it does not enlarge or confer powers on administrative agencies or officers.[30] Where the enacting or operative parts of a statute are unambiguous, the meaning of the statute cannot be controlled by language in the preamble. The operative provisions of statutes are those which prescribe rights and duties and otherwise declare the legislative will. In the context of this case, the operative provisions of the statute which declare the will of Congress with respect to railroad noise emissions are those contained in Section 17 of the Act. We find the reference to "the equipment and facilities" in Section 17(a)(1) to be unambiguous and, therefore, do not look to the preamble for guidance as to the legislative intent.

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[28] Respondents refer us to other statutory language in various subsections of Section 17; *see* Brief for Respondents at 12-14. We find these arguments to be clearly frivolous and insubstantial and therefore do not address them in detail in this opinion.

[29] 42 U.S.C. § 4901(a)(3).

[30] *See, e.g., Yazoo Railroad Co.* v. *Thomas*, 132 U.S. 174, 188 (1889).

B. *Legislative History*

Our conclusion that the language of Section 17(a)(1) itself is an unambiguous reference to all "equipment and facilities" forecloses the necessity of looking to the legislative history for resolution of this issue. In the interest of thoroughness, however, we have scrutinized the legislative history and believe that it is consistent with our reading of the language of the Act. In addition, the legislative history provides an important insight into why the justification offered by the EPA for the narrowness of the scope of its regulations is incorrect.

The only legislative Committee Report to touch on the provisions relating to railroad noise regulation is the Report of the Senate Committee on Public Works.[31] The Report of the House Committee on Interstate and Foreign Commerce, accompanying the House noise control bill (H.R. 11021),[32] contains no mention of railroad noise emissions because the House bill did not contain a section on railroad noise either as introduced or as first passed by the House.

The Senate Committee Report summarized the railroad section of the law as follows:[33]

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[31] S. Rep. No. 92-1160, 92d Cong., 2d Sess. (1972).

[32] H. Rep. No. 92-842, 92d Cong., 2d Sess. (1972).

[33] S. Rep. No. 92-1160, *supra*, note 31, at 18-19.

> "*Part B—Railroad Noise Emission Standards*
>
> This part (Sections 511 through 514) provides a Federal regulatory scheme for noise emissions from surface carriers engaged in interstate commerce by railroad. The Administrator of the Environmental Protection Agency is required to publish within 9 months after enactment and promulgate within 90 days after publication noise emission standards for railroad equipment and facilities involved in interstate transportation, including both new and existing sources. Such standards must be established on the basis of the reduction in noise emissions achievable with the application of the best available technology, taking into account the cost of compliance.
>
> Standards take effect after the period the Administrator determines necessary to develop and apply the requisite technology, and are implemented and enforced through the safety inspection and regulatory authority of the Secretary of Transportation, as well as through Title IV.
>
> Based on the interrelationship between the need for active regulation of moving noise sources and the burdens imposed on interstate carriers by differing State and local controls, the Federal regulatory program for railroads under this part completely preempts the authority of State and local governments to regulate such noise after the effective date of adequate Federal standards, except where the Administrator determines it to be necessitated by special local conditions or not in conflict with regulations under this part."

Although the language in the report offers no insight into the meaning of the phrase "equipment and facilities," it does provide evidence as to the major policy justification for the broad preemptive effect accorded to the railroad noise emission standards. Congress was clearly concerned about "the burdens imposed on interstate carriers by differing State and local controls. . . ." This concern was expressed repeatedly in the Senate debate on the Act. Two excerpts from this debate serve to illustrate this concern:

Senator Randolph:

> "I also bring to the attention of the Senate the provisions in title V of S. 3342, which establishes a regulatory framework for noise from interstate trucks and buses and the operations of railroads. Here, as well as in the area of product noise emission standards, the transportation industry is faced with the prospect of conflicting noise control regulations in every jurisdiction along their routes. It is completely inappropriate for interstate carriers or interstate transportation to be burdened in this way. The committee met the need for active legislation on moving noise sources by requiring controls on noise from all interstate trucks and buses and railroads, including existing equipment which would not otherwise be subject to produce noise emission standards under title IV and the patterns of operations of such carriers. After the effective date of an adequate Federal regulation program, the authority of State and local governments to regulate noise from interstate trucks and buses or trains is completely preempted, except where the Administrator determines it would be necessitated by special local conditions or in no conflict with the Federal requirements." [34]

* * * *

> "Mr. HARTKE. Mr. President, one of the basic purposes of title V of this bill, as explained in the committee report, is to assure the maximum practical uniformity in regulating the noise characteristics of interstate carriers such as the railroads and motor carriers which operate from coast to coast and through all the States, and in hundreds of communities and localities.

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[34] 118 Cong. Rec. 35412 (1972) (Remarks of Senator Randolph).

> "Without some degree of uniformity, provided by Federal regulations of countrywide applicability which will by statute preempt and supersede any different State and local regulations or standards, there would be great confusion and chaos. Carriers, if there were not Federal preemption, would be subject to a great variety of differing and perhaps inconsistent standards and requirements from place to place. This would be excessively burdensome and would not be in the public interest." [35]

This concern for "maximum practical uniformity" is *certainly* consistent with a broad definition of "equipment and facilities." But the EPA has put forth a curious notion as to which equipment and facilities are in need of such uniform treatment with respect to noise emission standards.

EPA justifies its narrow view of equipment and facilities by arguing that if a source of noise is subject to the regulation of only one jurisdiction, there is no need for national uniformity. EPA believes that national uniformity is needed only in those situations in which the noise source is potentially subject to noise regulation by more than one jurisdiction (such as locomotive or rail cars).[36] This view ignores the fact that, although a physical source of noise—for instance, a particular yard or terminal ("facilities")—may be permanently located in only one jurisdiction, the *railroad that owns it* will own other yards and terminals in many other jurisdictions through which its system extends. The railroad itself (the carrier specified in Section 17(a)(1) of the Act), as distinguished from the single yard, will be subject to conflicting or differing noise regulations of the jurisdictions in which all of the various yards are located. Such multiple exposure could easily create the type of burdens which Congress sought to avoid in the Noise Control Act. By giving the phrase "the equipment and facilities" its natural meaning, nationally uniform regulations will extend to the various elements subsumed in this phrase, in furtherance of this major policy underlying the Act.

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[35] 118 Cong. Rec. 35881 (1972) (Remarks of Senator Hartke).

[36] *See* Background Document, J.A. at 37-45.

We emphasize that the discussion in this section of the opinion concerns a policy justification underlying the Act and does not focus on the statutory language. There is no language in Section 17 which mandates that the Administrator regulate *only* those equipment and facilities in need of national uniform treatment. But this question of uniformity is supportive of our reading of the contested phrase, and the manner in which the Administrator applied the uniformity concept is important to an understanding of the EPA's earlier, limited action. It is for these reasons that we have discussed this issue.

C. *Other Arguments*

The analysis thus far in Part II has focused on the statute itself and the legislative history. We now address several additional arguments raised by the EPA.

The EPA argues that its interpretation of the Noise Control Act should be accorded deference by a reviewing court because it is the agency charged with administering the Act.[37] While it is an established principle of administrative law that reviewing courts will generally "show 'great deference to the interpretation given [a] statute by the officers or agency charged with its administration,' "[38] this principle has no application where, as here, the agency has misinterpreted its statutory mandate.[39]

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[37] *See* Brief for Respondents at 7-8.

[38] *Udall* v. *Tallman*, 380 U.S. 1 (1965).

[39] *See, e.g., Freeman* v. *Morton*, 499 F.2d 494 (D.C. Cir. 1974).

In such cases of misinterpretation, it is our duty to correct the legal error of the agency as we have done here. In this regard, we also note that the Interstate Commerce Commission, the Department of Transportation, and the Department of Commerce—three federal agencies which can all lay claim to considerable expertise relative to the railroad industry and its role in interstate commerce—all strongly disagreed with the EPA's decision not to regulate all "equipment and facilities" of interstate rail carriers.[40] We point to this as additional evidence that our failure to defer to the agency decision in this case is not unwarranted.

The EPA argues quite strenuously that "practical factors" compel the conclusion that Congress did not intend all railroad equipment and facilities to be regulated.[41] EPA contends that "[i]t is inconceivable that Congress intended EPA to investigate and control every inconsequential piece of railroad equipment. . . ."[42] EPA then proceeds to list a variety of sources which it believes would be encompassed by the AAR's position in this case. EPA raises the specter that it will have to regulate elevators, air conditioners, typewriters, telephones, parking lots, and delivery vans because these sources are subsumed under a strict, literal interpretation of the phrase "equipment and facilities."[43]

We do not find this argument convincing. The courts are, of course, concerned with the consequences of the decisions which they render; they will examine these consequences as a factor in determining whether to grant the relief requested by the complaining party in a particular case. The consequences of the position we take in this case are not of the variety that cast doubt on the wisdom of the decision, however. This is because the position advocated by EPA *counsel* in this case is an artificial one; the AAR has not contended that the EPA must thrust its presence into every minute detail of railroad office buildings,[44] nor is such a position required by what appears to be the customary definition of "equipment and facilities" in the railroad industry.

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[40] *See* J.A. at 214-16, 210, 189.

[41] Brief for Respondents at 22.

[42] *Id.* at 23.

[43] *Id.* at 22-23

The EPA itself (as opposed to EPA counsel in this case) has shown that it is capable of defining "equipment and facilities" in a realistic and reasonable manner. In Section 5 of its "Background Document for Railroad Noise Emission Standards," the EPA has identified broad categories of railroad noise sources in order "to identify [the] types of equipment and facilities requiring national uniformity of treatment." [45] The agency then proceeds to list the following categories: office buildings; repair and maintenance shops; terminals, marshalling yards, humping yards, and railroad retarders; horns, whistlers, bells, and other warning devices; special purpose equipment (listing nineteen pieces of such equipment; track and right-of-way design; and trains (locomotives and rail cars).[46] As noted previously, the EPA chose to regulate only this last category relating to locomotives and rail cars.[47] *With respect to each of the additional categories* of railroad equipment and facilities that generate noise, the EPA declined to regulate *but reserved the option to establish standards in the future.*[48]

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[44] Reply Brief of Petitioners at 3-5.

[45] Background Document, J.A. at 37.

[46] *Id.*, J.A. at 37-44.

[47] *See* text at notes 14 to 19, *supra.*

[48] *See* note 46, *supra.*

Two points of significance emerge from the foregoing discussion. First, the EPA has demonstrated that it is capable of defining the phrase "equipment and facilities" in a manner consistent with customary usage of the phrase in the industry. Congress often does not specify in detail phrases that have an established meaning within a particular industry; such definitions are best developed with reference to the actual context of the regulated industry in question. We stress that the task of defining "equipment and facilities" is a matter to be accomplished within the structure of the EPA's rulemaking procedures; we do not undertake to provide a detailed definition in this opinion. We do, however, conclude that the EPA has interpreted its statutory mandate too narrowly in regulating only locomotives and rail cars, and *no* facilities at all. The EPA counsel have offered us an extreme definition of "equipment and facilities" in an attempt to have us reject the AAR's position. The EPA itself has shown that it can bring a measure of reason to a discussion of this definitional issue; on this on remand we rely.

The second point concerns EPA's insistence that it has the option to regulate the enumerated "equipment and facilities" in the future. In our view, the EPA has virtually admitted the error of its interpretation of Section 17 in making this argument. Section 17(a)(1) makes no provision for a "phasing in" of the required regulations over a period of time; the provision does not have a temporal element in which the agency determines *when* to initiate the federal regulatory machinery. There is a temporal element in Section 17(a)(2); this provision states that "such regulations may be *revised*, from time to time. . . ."[49] In this context, "such regulations" refers to the mandatory regulations prescribed in Section 17(a)(1). Section 17(a)(2) therefore provides for the "fine tuning" of the mandatory regulations; there is no provision for a delay in the timing of the *original issuance* of the mandatory standards themselves.

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[49] 42 U.S.C. § 4916(a)(2).

Therefore, if a certain subject matter is properly included within the term "equipment and facilities," the EPA has jurisdiction over the subject matter. If the EPA has such jurisdiction, it must exercise it in accordance with the mandate of Section 17(a)(1). In its "Background Document" *the EPA has claimed future jurisdiction over a broad range of "equipment and facilities;"* [50] this claim in effect admits that *the phrase properly encompasses a much broader range of objects and places. This admission in turn dictates the conclusion that the original regulations were much too narrow in scope.*

In its construction of Section 17(a)(1), the EPA has attempted to secure for itself the best of both worlds; that is, to limit current regulation while reserving plenary power to regulate in the future. This is perhaps an understandable effort to introduce an element of flexibility into the promulgation of noise emission standards. It is not, however, for us as a reviewing court to add this dimension of flexibility to the statutory framework. Congress has dictated that the EPA regulate "the equipment and facilities" of interstate rail carriers. Congress has *not* provided the agency with the type of discretion it evidently desires and contends for in this case. We are bound to effectuate the legislative will and we perceive it to be unambiguous in this context. If the EPA desires an element of flexibility in its operations, the agency must look to the Congress and not to the courts.

In addition to the arguments already presented, we perceive a highly unfavorable consequence of EPA's position that it can refrain to regulate at this time while reserving the option to regulate in the future. As noted previously, the EPA has encouraged local jurisdictions to regulate particular noise sources which it (the EPA) chooses not to regulate at this time. If the localities take this suggestion seriously, they may well invest considerable resources and time in developing and promulgating local noise ordinances. But the EPA claims the authority to issue regulations covering the *same* noise sources at *any* time in the future. It is clear that these EPA-issued regulations would, under Section 17(c)(1) of the Act, preempt the locally developed standards. Thus, the localities could not be sure when and if a federal regulation would displace their own and with it the time and resources devoted to the promulgation of the local standard. We believe that the structure of Section 17 of the Act comprehends some consideration for the localities in this regard.

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[50] *See* note 46, *supra.*

If the federal level issues all of its regulations concerning "equipment and facilities" at one time; the localities can plan their own activities in the area of noise regulation with increased certainty and confidence that their efforts will not go for naught. Also, once the federal regulations are issued, the localities will be able to discern whether or not they should attempt to trigger the variance provisions found in Section 17(c)(2) of the Act. Therefore, we believe that our decision in this case is consistent with the overall structure of the Act as it applies to railroad noise emission standards.

IV. RELIEF

Section 10(e) of the Administrative Procedure Act states that[31]

> [t]o the extent necessary to decision when presented, the reviewing court shall decide all relevant questions of law, interpret constitutional and statutory provi-

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[31] 5 U.S.C. § 706.

> sions, and determine the meaning of applicability of the terms of an agency action. The reviewing court shall—
>
> (1) compel agency action unlawfully withheld or unreasonably delayed.
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> * * * *

Having concluded that the Administrator of the EPA misinterpreted the clear statutory mandate to regulate "the equipment and facilities" of interstate rail carriers, we direct that the Administrator reopen the consideration of Railroad Noise Emission Standards and promulgate standards in accordance with the statutory mandate as interpreted herein. Several observations concerning the nature of the inquiry on remand are in order.

Although the Administrator construed the term "equipment and facilities" in a narrow and artificial manner, we do not in this opinion dictate what we believe to be a proper definition of the term. Rather, we believe that Congress intended for this definition to be developed by the agency in a manner that is consistent with the customary usage of the phrase in the railroad industry.[52] The EPA has shown that it has a realistic understanding of what is included within railroad "equipment and facilities," and we would expect them to apply this same realistic approach on remand. This does not mean that they must adopt the precise definition outlined in Section 5 of the Background Document; it does mean that the realities of the railroad industry must govern the definition, not the predilections of the agency as to what it is prepared to regulate.

Second, nothing we do herein affects the *degree* of regulation which the Administrator deems desirable in a particular context. We are concerned at this point only that the Administrator broaden the scope of the *subject matter* regulated so as to bring the coverage of the regulations in line with the Congressional mandate in Section 17 of the Act. The particular *manner* in which the "equipment and facilities" are regulated is a matter which rests, in the first instance, with the Administrator. This action is, of course, reviewable, but under a different standard and at a future date.

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[52] This definition will, of course, be reviewable in the courts.

Third, there is the matter of the time within which the Administrator must promulgate the regulations concerning "equipment and facilities." The original statutory command was that the Administrator publish proposed regulations within nine months from 27 October 1972;[33] these proposed regulations were then to be promulgated as final regulations within ninety days after the publication of the proposed regulations.[34] We believe that this original timetable evidences a Congressional concern that the regulations be issued expeditiously. Accordingly, we believe that our mandate should embrace this concern for a prompt treatment of the noise emission standards. Therefore, we direct that the consideration on remand proceed as promptly as possible and, in any event, that the final regulations be issued within one year from the date on which the mandate in this case is issued.

Fourth, and finally, our holding in this case does not affect the validity of the individual Railroad Noise Emission Standards already issued. These may continue in effect. Our sole directive is that the EPA broaden the scope of its regulations by defining "the equipment and facilities" of interstate rail carriers in a manner consistent with the usual and customary understanding of the phrase in the railroad industry.

So Ordered.

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[33] 42 U.S.C. § 4916(a)(1).

[34] *Id.* at § 4916(a)(2).

APPENDIX P

FINANCIAL ANALYSIS/IMPACT ASSESSMENT OF PROPOSED REGULATORY OPTIONS

PART A: Financial Impact Analyses

INTRODUCTION

This analysis examines the potential financial impact on individual railroads of proposed noise abatement regulations. For each of more than 50 railroads the present value of future cash flow (net income plus depreciation) is compared with the present value of future abatement costs plus net worth. For those railroads where the costs plus net worth are greater than or only slightly less than cash flow, or where abatement costs appear large relative to cash flow, it may be concluded that the cost of compliance of the proposed regulation could impose some hardship on the companies.

Results

Based upon the results of the analyses, the followingd observations are made:

1. Several railroads appear to be in financial difficulty, even before considering the costs of noise abatement. Six railroads show negative net worth as of December 31, 1977, and eight additional railroads experienced a negative cash flow over the 1975-77 period.

2. In no instance was the present value of noise abatement costs greater than the difference between cash flow and net worth. Thus, the costs attributable noise to the proposed regulations should not shift any railroad from a positive difference (between cash flow and net worth plus cost) to a negative difference difference.

3. Generally, abatement costs are small relative to cash flow or net worth. However, for a few railroads the estimated costs seem significant. This is particularly true for the major switching and terminal companies, where yard operations represent a significant part of total firm activity. A separate discussion of the impact of the proposed regulations on switching and terminal companies appears in Part B of this Appendix.

DISCUSSION

This analysis assesses the potential financial impact of the revised noise abatement regulation on individual line haul railroads and switching and terminal companines. The nationwide regulations considered in this analysis require a staged reduction of noise levels for three types of railroad yards--hump, flat classification and flat industrial. The timetable used in this analysis for these reductions is as follows:

Regulations Announced January 1, 1980

Facility	Standard, dB	Effective Date
All Yards	L_{dn} 70	January 1, 1982
Hump Yards Only	L_{dn} 65	January 1, 1985

The abatement cost estimates for each yard type, separated into capital and operations and maintenance (O&M) components, are displayed in Table P-1.

Included in this analysis are all Class I line-haul railroads and switching and terminal companies (according to the ICC classifications after 1976) and Class II line-haul roads which operate hump yards. Fifty-six railroads companies were analyzed.

METHODOLOGY

Overview

The methodology used to assess each railroad's financial condition was to compare the present value (PV) of its twenty year (1980-1999) stream of cash flow to the PV of noise abatement costs for the same period, plus

TABLE P-1

ESTIMATED QUIETING COSTS
CAPITAL AND OPERATING & MAINTENANCE
RAILROAD YARDS

Study Level & Yard Type	# Yards	Capital Cost		Annual Maint.	
		Total ($000)	Avg/Yd	Total ($000)	Avg/Yd
L_{dn} 70					
Hump	124	18,352	148.000	1,304	10.516
Flat-Classification	1,113	19,990	17.960	3,324	2.987
Flat-Industrial	1,381	8,772	6.352	3,891	2.818
L_{dn} 65					
Hump	124	58,312	470.258	19,158	154.500

its current net worth. Cash flow equals the sum of net income after interest and income taxes, plus depreciation and amortization. Net worth equals the difference between assets and liabilities and is composed of stock and retained earnings. The noise abatement costs for capital and O&M are estimated for each railroad from the data shown in Table P-1. The present values are then analyzded to assess financial health and impact of noise abatement costs.

Data Sources

The individual railroad financial data were gathered from the reports submitted annually by each railroad to the ICC. Data were gathered for three years--1975, 1976 and 1977. The reports used were the R-1 (for Class I railroads) and the R-2 (for Class II railroads). The net worth data were taken from the Comparative General Sheet (Schedule 200) and represent total shareholders' equity. Net income is from the last line of Schedule 300, Income Account. Depreciation and amortization expenses were found in Schedule 309, Statement of Changes in Financial Condition.

The estimated cost for each type of yard, as derived from Table P-1 and explained below, was multiplied by the number of each type of yard owned by individual railroads. Yard ownership data are found in Appendix E of this Background Document.

The cash flow and net worth data were averaged over the 1975-77 period, generating a single estimate. This "smoothing" technique reduced the prospect of choosing an unrepresentative base period from which the 20-year projections were derived.

Present Value Analysis

Assumptions

1. Horizon equals 20 years (January 1, 1980 to December 31, 1999).
2. Annual inflation rate equals 6%.
3. Discount rate for present value analysis equals 10%.
4. Marginal tax rate equals 50%.
5. Noise abatement equipment and materials depreciated over ten years by straight line, with salvage value equal to zero.

Computations

1. Cash Flow - The 1975-77 average is assumed to be the first observation in the annual stream beginning January 1, 1980. For each railroad, the cash flow average was inflated by 6% per year, discounted by 10% and summed to derive a net present value of the 20-year stream of cash flows. This is equivalent to a present value of annuity calculation.

2. Net Worth - the 1975-77 average was assumed to be the net worth as of January 1, 1980.

3. Noise Abatement Investment - For each type of yard, the capital investment requirements in 1983 and 1986 were generated by inflating the appropriate investment data of Table P-1 by 6% per year from January 1, 1980, then discounting this investment back to January 1, 1980, using a 10% discount rate.

4. Operating & Maintenance -

a. Annual Expenses - The annual operating and maintenance expenses for each type of yard, as shown in Table P-1, were converted to a present value as of January 1, 1983 or January 1, 1986, using the inflation and discounting technique for an annuity described above for the cash flow calculation. The 1983 or 1986 present values were then discounted to 1980. These totals were then multiplied by .5, yielding an effective after tax O&M abatement cost.

b. For each investment (as of January 1, 1983 or January 1, 1986), ten-year depreciation expense streams were computed (one-tenth of capital required). These series were then converted to an after tax basis and discounted to the appropriate investment date, then discounted to 1980.

c. Present Value-O&M--For each effective control date (January 1, 1983 or January 1, 1986), the present value of after tax depreciation costs was subtracted from the present value of O&M costs, thus recognizing the cash-saving nature of depreciation. These new totals were then discounted to January 1, 1980.

5. Compute the NPV - The present value of abatement costs (capital plus O&M) was added to the net worth. This sum was subtracted from the present value of cash flow.

Table P-2 lists the financial characteristics and their treatment in this analysis.

ANALYSIS OF RESULTS

The basic analysis concentrates on the difference between the present value of cash flow and the present value of net worth plus abatement costs.

1. If this difference is negative (or if the net worth or the present value of cash flow is negative), the individual railroad may be in financial difficulty and may be trouble financing or implementing the changes specified by the noise control regulations.

TABLE P-2

SUMMARY OF THE TREATMENT OF FINANCIAL ITEMS

Item	Years Covered	Averaging Applied	Discount Rate Applied	Inflation Rate Applied	Rate Tax Applied	Comments
Net Income	1980-89	Yes	10%	6%	None	Already reflects tax
Depreciation	1980-89	yes	10%	6%	None	Already reflects tax
Net Worth	1980	yes	None	None	None	Net worth treated as one year cost
Implementation Costs: Capital	1983 Hump Flat 1986 Hump flat-class. flat-indus.	None	10%	None	50% on depreciation	Depreciation is by straight-line method and 10 yr. life
O&M	1983-85 hump Flat-cl 1986-99 hump flat-cl. flat-ind.	None	10%	6%	50%	Depreciation expense (above) substracted from O&M expense

2. If the difference is positive, but relatively small, potential financial difficulty may be present. For this analysis, relatively small is interpreted to mean a different positive, but less than 10% of net worth.

3. For railroads with a positive difference greater than 10%, further analysis is suggested only if abatement costs appear unusually large relative to other data. This is the case for a few railroads, notably switching and terminal companies, as discussed below.

4. For the remaining railroads, no further analysis is suggested. However, this should NOT be interpreted as conclusion that these remaining railroads are financially healthy and will not be impacted by the proposed action. The limitations in this analysis prevents a broader conclusion. For these latter railroads, it can only be concluded that this specific analysis fails to uncover potential financial weaknesses.

Individual Railroad Results

The computations described above were completed for each of the railroads under consideration. An analysis of the results of these calculations lead to the following grouping of railroads:

I. Railroads with negative net worth.
II. Railroads with negative present value of cash flow.
III. Railroads with negative difference, although cash flow and net worth both positive.
IV. Railroads with difference positive, but less than 10% of net worth.
V. Other railroads.

The results of the analysis for the above five groups of railroads are shown in Table P-3. These tables show the present value of cash flow, the net worth, the present value of abatement costs, and the difference. Also, shown for each railroad are two percentages--the difference as a precent of net worth, and total abatement costs as a percent of cash flow. Examination of these results suggests the following (no significance should be attached to the following order of presentation):

1. A number of railroads appear to be in serious financial difficulty before considering potential costs of noise abatement. While abatement costs undoubtedly will add to their difficulty, the underlying weakness is already present and cannot be attributed to noise regulation.

2. Each of those railroads for which the difference is negative would continue to show a negative in the absence of abatement. Thus noise abatement regulations did not change any railroad from a positive difference to a negative difference.

3. Three of the railroads in the negative cash flow group are presently in a Section 77 Trusteeship. These are the Boston and Maine, Chicago, Rock Island and Pacific, and Chicago, Milwaukee, St. Paul and Pacific. While Section 77 Trusteeship is short of outright bankruptcy, trustees have been appointed to manage the assets of the three railroads. The trustees do have the power to restructure the debt of these firms, which likely will amount to consolidation and lenghtening of outstanding bonds and other loans.

4. A number of the railroads appearing in these lists are subsidiary of other roads, parts of larger railroad systems, or subsidiaries of other corporations. Thus it is possible that the individual firm's financial position should not be analyzed independently but instead considered as a part of the overall organization of which the company is a part. To gain insight into this issues, and to summarize the results, the information in Table P-4 has been prepared.

The railroads in this list are from the following groups: negative net worth, negative cash flow, negative difference, difference positive, but small, and other. This latter group includes four railroads which seem financially strong, but whose noise abatement costs appear significant.

Included in Table P-4 for each railroad is: the name of the parent corporation; the number of yards owned, by yard type, data on abatement costs, costs as a percent of cash flow, and difference as a percent of net worth, all taken from Table P-3; sales and income data for the firm and for the parent; and Moody's bond rating for parent company issues.

Before examining individual railroads and their ownership patterns, it is appropriate to consider why parent firms would maintain or subsidize financially unhealthy subsidiaries or affiliates. Several explanations are possible:

1. Tax considerations--Circumstances unique to the firm, its parent or the industry may offer significant tax incentive to maintaining the operations of an apparently unprofitable or unhealthy subsidiary. Aspects of the tax law make this general statementd particularly applicable to the railroad industry.

2. Nature of subsidiary operation--Many of the railroads examined here are not independent entities, but instead are integral parts of a larger operation. Examples include: Terminal Railroad Association of St. Louis and the Belt Railway of Chicago are owned by groups of line-haul railroads and provide diverse and essential services to their owners in the respective cities. The Duluth, Missabe and Iron Range is an integral part of U.S. Steel's iron ore mining and transportation system in the upper Great Lakes. In these cases, it is difficult to analyze the railroad separately from the broader operation of which the railroad is a part.

3. Future potential--The parent may have expectations of eventually turning the unprofitable subsidiary into a profitable operation.

TABLE P-3, CON'T

SUMMARY OF RAILROAD FINANCIAL CONDITION CASH FLOW, NET WORTH AND ABATEMENT COSTS

0.1 > DIFF : NVV > 0
$(000)

Railroad	Net Present Value 1/ Cash Flow 2/ (1)	Net Worth (2)	Abtmnt Capital (3)	Cost O&M (4)	NW + Cost 2+3+4 (5)	Diff 1-5 (6)	Abtmnt Cost % CF (3+4)/1 (7)	Diff % NW 6/2 (8)
Duluth, Missabe & Iron Range	85176	84085	120	74	84279	897	0.2	1.1
Bangor & Aroostook	39779	36905	108	47	37060	2719	0.4	7.4
Colorado & Southern	81153	74863	88	68	75019	6134	0.2	8.2
Burlington Northern	1927097	1757820	8438	6935	1773193	153904	0.8	8.8

TABLE P-3, CON'T

SUMMARY OF RAILROAD FINANCIAL CONDITION
CASH FLOW, NET WORTH AND ABATEMENT COSTS

NEGATIVE CASH FLOW
$(000)

Railroad	Net Present Value 1/							
	Cash Flow 2/ (1)	Net Worth (2)	Abtmnt Capital (3)	Cost O&M (4)	NW + Cost 2+3+4 (5)	Diff 1-5 (6)	Abtmnt Cost % CF (3+4)/1 (7)	Diff % NW 6/2 (8)
oston & Maine	(141932)	48597	828	783	50208	(192140)	(1.1)	(395.4)
Indiana Harbor Belt	(13662)	13144	1676	1637	16457	(30119)	(24.3)	(229.2)
hicago, Rock Island Pacific	(308635)	143335	2084	1679	147098	(455733)	(1.2)	(318.0)
orthwestern Pacific	(41707)	21007	38	20	21065	(62772)	(0.1)	(298.8)
ong Island	(1672764)	113048	552	553	114153	(1786917)	(0.1)	(1581.0)
hi., Milw., St. Paul Pacific	(112111)	304135	3280	2439	309854	(421965)	(5.1)	(138.7)
elware & Hudson	(45870)	37968	354	209	38531	(84401)	(1.2)	(222.3)
etroit, Toledo & Ironton	(22394)	44374	640	621	45635	(68029)	(5.6)	(153.3)

TABLE P-3, CON'T

SUMMARY OF RAILROAD FINANCIAL CONDITION CASH FLOW, NET WORTH AND ABATEMENT COSTS

NEGATIVE NET WORTH
$(000)

Railroad			Net Present Value 1/					
	Cash Flow 2/ (1)	Net Worth (2)	Abtmnt Capital (3)	Cost O&M (4)	NW + Cost 2+3+4 (5)	Diff 1-5 (6)	Abtmnt Cost % CF (3+4)/1 (7)	Diff % NW 6/2 (8)
Central Vermont	13135	(12068)	82	54	N/A	N/A	1.0	N/A
Missouri, Kansas Texas	(44634)	(27903)	512	105	N/A	N/A	(1.4)	N/A
Grand Truck Western	19598	(109192)	450	228	N/A	N/A	3.5	N/A
Conrail	(7540800)	(26595)	24162	21945	N/A	N/A	0.6	N/A
Youngstown & Southern	9654	(113)	508	519	N/A	N/A	10.6	N/A
Terminal Railroad Association of St. Louis	9258	(1651)	602	601	N/A	N/A	13.0	N/A

TABLE P-3, CON'T

SUMMARY OF RAILROAD FINANCIAL CONDITION
CASH FLOW, NET WORTH AND ABATEMENT COSTS
CASH FLOW-(NET WORTH + ABTMT COST) > 0.1

NET WORTH
($000)

NET PRESENT VALUE^1/

Railroads	Cash Flow2/ (1)	Net Worth (2)	Abtmnt Capital (3)	Cost O&M (4)	NW + Cost 2+3/4 (5)	Diff% 1-5 (6)	Abtmnt Cost% CF (3+4)/1 (7)	Diff NW 6/2 (8)
Elgin Joliet & Eastern (EJE)	154692	71797	628	593	73018	81674	0.8	113.8
Norfolk & Western (N&W)	2252003	1074400	6120	4830	1085350	1166653	0.5	108.6
Baltimore & Ohio (B&O)	1016671	694061	5782	4724	704567	312104	1.0	45.0
Missouri Pacific (MOPAC)	1502371	539492	2792	2189	544473	957898	0.3	177.6
Kansas City Southern	167411	118757	304	162	119223	48188	0.3	40.6
Denver & Rio Grande Western	358401	195279	640	621	196540	161861	0.4	82.9
Duluth Winnepeg & Pacific	78629	14252	6	13	14271	64358	0.02	451.6
Toledo Peoria & Western	14175	10129	38	20	10187	3988	0.4	39.4
Texas Mexican	9709	4280	64	13	4357	5362	0.8	125.0
Chicago Illinois & Midland	39127	19010	76	40	19126	20001	0.3	105.2
Western Maryland	119462	82704	706	572	83982	35480	1.1	42.9
Union Pacific	2507155	1300444	3210	2703	1306357	1200798	0.2	92.0
Chesapeake & Ohio	1638449	651176	4192	3306	658674	979775	0.5	150.0
Richmond Fredericksburg & Potomac	154361	79287	1048	1044	81379	72982	1.4	92.0
Louisville & Nashville (L&N)	891272	526721	3252	2997	532970	358302	0.7	68.0
Atchison, Topeka & Sante Fe	1776854	1337992	3982	2936	1344910	431944	0.4	32.3
Illinois Terminal RR	20153	21864	140	54	13058	7095	1.0	55.2

TABLE P-3 CON'T

SUMMARY OF RAILROAD FINANCIAL CONDITION
CASH FLOW, NET WORTH AND ABATEMENT COSTS
CASH FLOW-(NET WORTH + ABTMT COST) > 0.1

NET WORTH
($000)

NET PRESENT VALUE[1]/

Railroads	Cash Flow2/ (1)	Net Worth (2)	Abtmnt Capital (3)	Cost O&M (4)	NW + Cost 2+3/4 (5)	Diff% 1-5 (6)	Abtmnt Cost% CF (3+4)/1 (7)	Diff NW 6/2 (8)
Seaboard Coast Line	1452910	1126293	3012	2954	1132259	320651	0.4	28.5
Florida East Coast	112375	94675	114	61	94820	17555	0.2	18.5
Bessemer & Lake Erie	197786	93009	140	54	93203	104583	1.0	112.0
Soo Line	302565	159149	706	251	160136	142429	0.3	89.5
Southern Pacific	2028918	1513066	5340	5134	1523540	505378	0.5	33.0
Detroit & Toledo Lake Shore	17707	11036	508	535	12079	5623	5.9	51.0
St. Louis - Southwestern	723160	286542	834	598	287974	435186	0.2	151.9
St. Louis - San Francisco	366142	225094	1674	1409	228177	137965	0.8	61.3
Alton & Southern	36663	20386	508	519	21413	15250	2.8	74.8
Belt RR of Chicago	9126	6201	1066	1086	8353	773	23.6	12.5
Pittsburgh & Lake Erie	202086	163271	170	121	163562	38524	0.1	23.6
Southern	1899164	1028221	5312	5004	1038537	860627	0.5	8.4
Chicago & Northwestern	205181	14345	2804	1636	18785	186396	2.2	129.9

TABLE P-3, CON'T

SUMMARY OF RAILROAD FINANCIAL CONDITION CASH FLOW, NET WORTH AND ABATEMENT COSTS

COST + NW > CASH FLOW
$(000)

Railroad	Net Present Value 1/							
	Cash Flow 2/ (1)	Net Worth (2)	Abtmnt Capital (3)	Cost O&M (4)	NW + Cost 2+3+4 (5)	Diff 1-5 (6)	Abtmnt Cost % CF (3+4)/1 (7)	Diff % NW 6/2 (8)
Ft. Worth & Denver	27837	32888	160	32	33080	(5234)	0.7	(16.0)
Illinois Central Gulf	518544	678252	3824	3040	685116	(166572)	1.3	(24.6)
Maine Central	31047	39828)	108	48	39984	(8937)	0.5	(22.4)
Western Pacific	119656	123380	196	114	119966	(310)	0.3	(3.3)

RAILROAD AGREEMENT COST, FINANCIAL IMPACT OWNERSHIP SUMMARY

TABLE P-4

					ABATEMENT COST			NET CASH	FIRM						MOODY's
Class	FIRM/NAME PARENT/NAME	No. Yards H	FC	FI	Present Value ($000) Capital	O&M	% PV of Cash flow	Flow as % of NW	Net Income ($ M)	Sales 1977	M%	Net Income ($ M)	Sales 1977	M%	Bond Rating
	NEGATIVE NET WORTH														
I	Conrail/USRA	32	191	299	24,162	21945	1	N/A	(631.352)	3086.06	N/A	N/A			
	Terminal RR Assn. of St. Louis/Various	1	2	5	602	601	13	N/A	.615	41.594	1.48	N/A			
	Youngstown & Southern/Montour RR/Pittsburg/ & Lake Erie RR/ Penn Central Co	1	0	0	508	519	11	N/A	.122	555.587	.02				
I	Grand Truck Western/Grand Truck Corp./ Canadian Nat'l Ry.	0	12	11	450	228	4	N/A	1.711	174.94	0.97		11.7[1/]	2162[1/]	1[1/]
I	Missouri, Kansas Texas/Katy Industries	0	13	3	512	105	(1)	N/A	(5.572)	117.19	N/A		12	176	7
	Central Vermont/ Grand Truck Corp./Canadian Nat'l Ry.	0	2	3	82	54	1	N/A	176	13.27	13.26		11.7[1/]	2162[1/]	1[1/]

1/ 1976 data

2/ line 501, R-1

RAILROAD AGREEMENT COST, FINANCIAL IMPACT OWNERSHIP SUMMARY

TABLE P-4, CON'T

					ABATEMENT COST			NET CASH	FIRM						MOODY's
Class	FIRM/NAME PARENT/NAME	No. Yards H	FC	FI	Present Value ($000) Capital	O&M	% PV of Cash flow	Flow as % of NW	Net Income ($ M)	Sales 1977	M%	Net Income ($ M)	Sales 1977	M%	Bond Rating
	NEGATIVE NET WORTH														
I	Illinois Central Gulf/I C Industries, Inc.	4	47	48	3824	3040	1	(25)	3.339	671.871	0.50	78.5	1873	4	A
I	Western Pacific/ Western Pacific/ Industries	0	5	6	196	114	-	(3)	4.814	127.237	3.78				
I	Ft. Worth & Denver/Colorado & Southern/Burlington Northern	0	5	0	160	32	1	(16)	2.146	52.266	4.11	61	1677	4	A
I	Maine Central/ Greyhound Corp.	0	3	2	108	48	1	(22)	.803	41.555	1.93	82.5	3852	2	Ba
	0.1 > (Net CF : NW) > 0														
I	Burlington Northern/Independent	10	89	85	8438	10935	1	9	74.903	1677.86	4.46				
I	Duluth Missable & Iron Range/ U.S. Steel	0	3	4	120	74	-	1	(2.861)	46.745	N/A	138	9609	1	Aa
I	Bangor & Aroostook/ Independent	0	3	2	108	47	-	7	1.081	19.583	5.52				
I	Colorado & Southern/Burlington Northern	0	2	4	88	68	-	8	5.222	53.856	9.70	138	9609	1	Aa

RAILROAD AGREEMENT COST, FINANCIAL IMPACT OWNERSHIP SUMMARY

TABLE P-4, CON'T

					ABATEMENT COST			NET CASH	FIRM						MOODY's
Class	FIRM/NAME PARENT/NAME	No. Yards H	FC	FI	Present Value ($000) Capital	O&M	% PV of Cash flow	Flow as % of NW	Net Income ($ M)	Sales 1977	M%	Net Income ($ M)	Sales 1977	M%	Bond Rating
	NEGATIVE NET WORTH														
I	Chicago Milawkee St. Paul & Pacific RR/ Independent	3	47	42	3280	2439	(5)	(139)	(36.247)	444.50	N/A				
I	Chicago Rock Island & Pacific/ Independent	2	27	34	2084	1679	(1)	(318)	(34.834)	362.97	N/A				
I	Indiana Harbor Belt/Conrail	3	4	4	1676	1637	(24)	(229)	(3.233)	44.987	N/A				
I	Boston & Maine Bomaine	1	7	16	828	783	(1)	(395)	5.614	85.54	N/A	5.6	85	7	
I	Detroit, Toledo & Ironton/Penn Central	1	3	6	640	621	(6)	(153)	2.259)	62.08	3.4				
I	Long Island RR/ MTA of NY	1	1	2	552	553	0	(1581)	(121.566)	135.16	N/A				
I	Delware & Hudson/ Dereco-Norfolk & Western	0	9	11	354	209	(1)	(222)	(12.028)	89.10	N/A	103	1241	8	Aa
I	Northerwestern Pacific/Southern Pacific	0	1	1	38	20	0	299	(2.68)	14.88	N/A	79.5	1560	5	

RAILROAD AGREEMENT COST, FINANCIAL IMPACT OWNERSHIP SUMMARY

TABLE P-4, CON'T

Class	FIRM/NAME PARENT/NAME	No. Yards			ABATEMENT COST Present Value ($000)			NET CASH	FIRM						MOODY's
		H	FC	FI	Capital	O&M	% PV of Cash flow	Flow as % of NW	Net Income ($ M)	Sales 1977	M%	Net Income ($ M)	Sales 1977	M%	Bond Rating
	PV Abtmt Costs : PV Cash Flow x 100>2														
I	Chicago & Northern/Independent	1	62	52	2804	1636	20	1299	(.46)	562.7	N/A				
I	Belt Ry. of Chicago/Various	2	1	3	1066	1086	29	13	.582	18.496	3.15				
I	Detroit & Toledo Shoreline/Norfolk & Western & Grand Truck Western/Canadian Nat'l Ry.	1	0	1	508	535	6	51	.818	13.184	6.2	11.7 1/	2162 1/	1 1/	
												103. 2/	1241 2/	8 2/	Aa 2/
I	Alton & Southern/St. Louis Southwestern & Missouri Pacific/Southern Pacific Trans. Co. (St. Louis Only)	1	0	0	508	519	3	75	1.913						
I	Union RR Co./U.S. Steel	1	3	2	676	702	3	13	1.935	69.140	2.8				

1/ 1976 - Canadian National, Parent of Grand Truck Western

2/ Norfolk & Western

3/ Line 562, R-1

4/ Line 501, R-1

PART B: Impact Assessment of Switching and Terminal Companies

There are approximately 80 railroad switching and terminal companies in the U.S. railroad industry. Only 5 of these 80 companies operating hump classification yards can be expected to incur significant noise abatement costs, resulting from the imposition of the proposed regulatory level or standard. These companies also operate flat classification and industrial yards which within the noise standard.

The 5 switching and terminal companies that can be expected to incur significant noise abatement expenses are the following:

- Indiana Harbor Belt Railroad Company
- The Alton and Southern Railway Company
- Terminal Railroad Association of St. Louis
- Union Railroad Company (Pennsylvania)
- Belt Railway Company of Chicago.

A preliminary assessment of the impact on each of these companies is described below.

Indiana Harbor Belt Railroad Company (IHB) is the largest of the railroad switching and terminal companies. The company operates 3 hump classification yards, 4 flat classification yards and 4 industrial yards. Assuming that the company would incur the estimated annualized cost of $231 thousand to quiet a typical hump classification yard, and $5 thousand each to quiet a typical flat classification yard and an industrial yard. The company's total cost to comply with the regulation would be $733 thousand.

In 1977 (the latest data appearing in Moody's Trasnportation Manual) the company handled 1.24 million cars. Allocating the increased cost according to the number of cars handled results in a per car increase in cost of 59 cents for noise abatement purposes. According to Moody's Transportation Manual, total operating expenses for car handling incurred by the company amount to approximately $34 per car. Adding the 59 cents in expenses amounts to an increase of 1.7 percent.

In considering whether the company is able to afford even this relatively modest increase in cost, it must be noted that Indiana Harbor Belt Railroad Company has been operating at a deficit in regard to its transportation operations since 1972. Furthermore, company deficits for railway operations have been increasing since 1972. In 1977, the deficit for railway operations reached $3.3 million.

In summary, although the cost impact appears to be modest for the Indiana Harbor Belt Railroad Company, it is impacting on a company that is already experiencing difficulty in covering its railway operating expenses.

The Alton and Southern Railway Company (ALS) operates 1 hump classification yard. If this company increases the amount of expenses estimated to be typical for hump yards to comply with the noise regulation, it would incur an additional annualized expense of $231,000.

Fifty percent interest in the Alton and Southern Railway Company was acquired in 1973 by the St. Louis Southwestern Railway Company. The other fifty percent interest in the company was acquired earlier by the Missouri Pacific Railroad Company (MOPAC). Inasmuch as the Alton and Southern Railway Company is owned by these two other companies, its operating and financial data are included with those of the parent companies. This prevents identifying the number of cars handled by the ALS yard. Nevertheless, assuming that the average car handling of hump classification yards applies, the ALS yard can be estimated to handle about 600,000 cars per year.

A pro-ration of the yard noise abatement costs would result in an added cost of 26 cents per car handled for the company. This added expense would represent an increase in the total cost of car handling by about 1 percent per annum.

As mentioned earlier, ALS is owned by two Class I line-haul railroads; namely, MOPAC and the St. Louis Southerwestern Railroad Co. Both of these parent companies are in relatively sound financial condition. The net operating income of MOPAC has increased steadily over the past five years, according to the most recent edition (1978) of Moody's Transportation Manual. Since 1972, MOPAC's net operating income has increased from $60.5 million to $150.9 million in 1977. MOPAC bonds are highly rated at Aa, indicating a secure financial position. The financial situation of the St. Louis Southwestern is also relatively sound. The company's net operating income over the past five years has fluctuated somewhat, around $33 million per annum. The Company's bonds have also been assigned high ratings (A-Aa), indicating a relatively secure financial position.

Terminal Railroad Assocation of St. Louis (TRRA) operates 8 yards that are estimated to require noise abatement expenditures. These 8 yards are comprised of 1 hump classification yard, 2 flat classification yards and 5 industrial yards. Assuming that these yards are typical in terms of the expenditures estimated for noise abatement, the hump yard would cost $231,000, and the others, at $5,000 each, would cost $35,000. The total estimated annualized cost would be $266 thousand.

The TRRA is owned by the railroad companies which it serves, including:

Baltimore and Ohio Railroad
Burlington Northern, Inc.
Chicago and Eastern Illinois Railroad
Chicago, Rock Island and Pacific Railroad
Illinois Central Gulf Railroad
Louisville and Nashville Railroad
Missouri-Kansas-Texas Railroad
Missouri Pacific Railroad
Penn Central System
St. Louis Southwestern Railway
St. Louis-San Francisco Railway.

TRRA provides diverse services to line-haul companies which makes it difficult to isolate classification and industrial yard operations. Its facilities include St. Louis Union Station, two bridges across the Mississippi River, engine terminals and 100 miles of main line, in addition to its yards.

Resorting once again to national averages, it can be estimated that the TRRA yards handle approximately 1.5 million cars per annum. The estimated annualized compliance costs by the company amounts to $266,000. On a per car basis, therefore, the added cost of noise abatement amounts to 18 cents per car handled. Although car handling costs cannot be separately identified for TRRA on the basis of data from other companies, it can be estimated that the added cost should amount to less than 1 percent of the total TRRA cost of car handling.

Since TRRA is owned by the companies that it services, the company's ability to assume the added expense essentially derives from the financial condition of the owning companies. As listed above, there are eleven owning companies, some of which are having financial difficulties. Various company bonds are guaranteed by the owning companies. These bonds have been rated Aa in Moody's Transportation Manual, indicating a relatively high security for the bonds.

The Union Railroad Company (PA) operates 16 yards comprised of 1 hump classification yard, 3 flat classification yards and 12 industrial yards. The company's estimated annualized expenditure requirements to comply with the proposed noise regulation would amount to $306 thousand.

Utilizing national averages for the types of yards owned, it can be estimated that the PA yards handle approximately 2.2 million cars per year in total. Expressed on a "per car handled" basis, this represents an added expenditure of 16 cents annually per car handled. Assuming that the total costs of car handling incurred by the PA are comparable to those incurred by other railroads, the added costs of noise abatement would add less than 1 percent to the total cost of car handling.

The PA is relatively profitable. Its operating ratio (operating expenses divided by operating revenues) was 77.3 percent. Total earnings for the company in 1977 were $42.3 million. Over the period reported in Moody's there has been a gradual increase in earnings beginning with $36.7 million in 1971. The PA is owned by U. S. Steel Corporation.

The *Belt Railway of Chicago* operates 6 yards, consisting of 2 hump classification yards, 1 flat classification yard, and 3 industrial yards. The company could incur annualized expenses of $482 thousand to comply with the noise regulation.

The company handled a total of 1.3 million cars in 1977, while incurring operating expenses of $16.3 million. This indicates an average expense of $13 per car handled.

The added expense incurred for noise abatement purposes, assuming the typical annualized expenditure of $482 thousand, would be 37 cents per car handled. This added expense for noise abatement purposes could increase total car handling costs by 2.8 percent.

The company provides car interchange services among its proprietor companies. The proprietor companies include the following:

Atchison, Topeka & Santa Fe Railway
Chesapeake and Ohio Railway
Burlington Northern, Inc.
Missouri Pacific Railroad
Chicago, Rock Island and Pacific Railroad
Consolidated Rail Corporation
Grand Trunk Western Railroad
Illinois Central Gulf Railroad
Soo Line Railroad
Norfolk and Western Railroad
Louisville and Nashville Railroad.

The operating agreement of the Belt Railway Company of Chicago provides for the division of working expenses and debt obligation on a user basis. The company's operating earnings have been approximately steady at $1 miillon per annum since 1971, the reporting period covered by the current *Moody's Transportation Manual*. An additional $1 million is earned as supplemental income. The company's debt obligations have been assigned an Aa rating, indicating a relatively secure financial position for the company.

APPENDIX R

SELECTION OF SAMPLE RAIL YARDS AND EXAMPLES OF EPIC ANALYSES

The random selection of 120 rail yards, per the procedure described in the text of Section 6, resulted in the initial list presented in Table R-1. The selection procedure provided 10 rail yards of each of 4 types in each of 3 place size locations for a total of 120 rail yards. However, due to lack of photographic imagery, many of the sample rail yards were eliminated from the analyses. Therefore, a substitute list was generated as shown in Table R-2. The final list of the 120 sample rail yards analyzed is presented in the text of Section 6.

The study area boundaries around two of the sample rail yards are shown as examples in Figures R-1 and R-2. The corresponding study area land use analyses by EPIC are shown in Figures R-3 and R-4. Also, typical data of rail yard dimensions and noise source locations relative to yard boundaries are shown in Figures R-5 and R-6.

TABLE R-1

INITIAL LIST OF SELECTED RAILROAD YARDS

CELL #1

YARD TYPES: Hump Classification PLACE SIZE: 50k People

STATE	CITY	YARD	RR
CO	Grand Junction	Train	DRGW
IL	Markham	Markham SBND	ICG
IN	Elkhart	Robt. P. Young Hump	PC
KY	Russell	Coal Class	CO
KY	Silver Grove	Stevens	CO
OH	Marion	Westbound	EL
OH	Portsmouth	W. B. Hump	NW
PA	Coatesville	Coatesville	RDG
PA	Morrisville	A	PC
WA	Pasco	Train BN	

CELL #2

YARD TYPE: Hump Classification PLACE SIZE: 50k-250k People

STATE	CITY	YARD	R/R
AR	North Little Rock	Crest	MP
AR	Pine Bluff	Gravity	SSW
CO	Pueblo	Train	ATSF
GA	Macon	Brosnan	SOU
NE	Lincoln	E. B. Hump	BN
OR	Eugene	Train	SP
PA	Harrisburg	Enola East	PC
TN	Chattanooga	De Butts	SOU
TN	Knoxville	John Sevier	SOU
TX	Beaumont	Train	SP

CELL #3

YARD TYPE: Hump Classificatiuon PLACE SIZE: 250k People

STATE	CITY	YARD	R/R
FL	Tampa	Rockport	SCL
IL	Chicago	Corwith	ATSF
IL	Chicago	59th Street	PC
IL	East St. Louis	Madison	TRRA
MI	Detroit	Flat Rock	DTS
OH	Columbus	Grandview	PC
OH	Toledo	Lang	DTS
PA	Allentown	Allentown E. Hump	LV
PA	Pittsburgh	Monon Junction	URR
WI	Milwaukee	Airline	CMSPP

TABLE R-1 (Continued)

CELL #4

YARD TYPE: Flat Classification PLACE SIZE: 50k People

STATE	CITY	YARD	R/R
IL	Belviderf	Train	CNW
IL	Streator	Train	PC
IA	Missouri Valley	Train	CNW
MI	Willow Run	Industrial	PC
MT	Helena	Train	BN
OH	Huron	South	NW
PA	Sayre	Sayre	LV
TX	Cleburne	Cleburne	ATSF
VA	Crewe	Train	NW
WV	Martinsburg	Cumbo	PC

CELL #5

YARD TYPE: Flat Classification PLACE SIZE: 50k-250k People

STATE	CITY	YARD	R/R
CA	Stockton	Mormon	ATSF
LA	Shreveport	Deramus	KCS
ME	South Portland	Rigby	PTM
MA	Lowell	Bleachery	BM
MA	Worcester	Worcester	BM
MI	Bay City	North	DM
OH	Lancaster	Lancaster	CO
OH	Lorain	South	LT
TX	Port Arthur	Train	SP
WA	Spokane	Yardley Train	BN

CELL #6

YARD TYPE: Flat Classification PLACE SIZE: 250k People

STATE	CITY	YARD	R/R
AZ	Tucson	Train	SP
FL	Jacksonville	Simpson	GSF
GA	Atlanta	Howell	SCL
IN	Jasonville	Latta	CMSPP
LA	New Orleans	Oliver	SOU
MI	Detroit	Davison Ave.	DT
MO	St. Louis	12th Street	MP
OH	Dayton	Needmore	BO
OR	Portland	Lake	PRTD
TN	Memphis	Hollywood	ICG

TABLE R-1 (Continued)

CELL #7

YARD TYPE: Flat Industrial PLACE SIZE: 50k People

STATE	CITY	YARD	R/R
AL	Ensley	Ensley	SOU
CA	E. Pleasanton	Train	SP
FL	Nichols	Dry Rock	SCL
IL	Chicago Heights	Heights	BO
IN	Burns Harbor	Burns Harbor	PC
MS	Durant	Durant	ICG
NE	McCook	Train	BN
NY	Troy	Troy	PC
OH	Washington Ct. Hse.	Train	BO
TX	Great Southwest	Great Southwest	GSW

CELL #8

YARD TYPE: Flat Industrial PLACE SIZE: 50k-250k People

STATE	CITY	YARD	R/R
CT	Stamford	Stamford	PC
FL	Pensacola	Whart	LN
GA	Columbus	Columbus	SCL
IN	Terre Haute	Hulman	CMSPP
MI	Ann Harbor	Ann Arbor	AA
MI	Muskegan	Train	CO
NE	Lincoln	Train	OLB
OH	Hamilton	Wood	BO
OH	Springfield	Int'l Harvester	PC
OR	Salem	Train	BN

CELL #9

YARD TYPE: Flat Industrial PLACE SIZE: 250k People

STATE	CITY	YARD	R/R
CA	San Jose	College Park	SP
IL	Chicago	43rd Street	CRIP
NY	Buffalo	Hamburg Street	EL
NY	New York	28th Street	EL
OH	Cincinnati	West End	LN
OH	Youngstown	McDonald	YN
OK	Tulsa	Lafeber	MIDLV
PA	Philadelphia	Midvale	PC
PA	Pittsburgh	Neville Island	POV
VA	Richmond	Belle Isle	SOU

TABLE R-1 (Continued)

CELL #10

YARD TYPE: Small Industrial Flat PLACE SIZE: 50k People

STATE	CITY	YARD	R/R
CA	Martell	Train	AMC
GA	Vidalia	Vidalia	SCL
KS	Durand	Train	MP
MD	Owings Mills	Maryland	WM
NY	Olean	Train	EL
PA	Cementon	Cementon	LV
SC	Hampton	Train	SCL
TX	Menard	Train	ATSF
WA	Gold Bar	Train	BN
WY	Pulliam	Train	BN

CELL #11

YARD TYPE: Small Industrial Flat PLACE SIZE: 50k-250k People

STATE	CITY	YARD	R/R
AR	Fort Smith	Train	MP
AR	Little Rock	E. 6th Street	MP
GA	Macon	Old CG	CGA
IL	Joliet	South Joliet	ICG
IL	Rockford	Rockford	CNW
KY	Ownesboro	Doyle	ICG
MN	Duluth	Missabi Jct.	DMIR
MT	Billings	Stock	BN
NC	Durham	Train	DS
PA	Erie	Dock Junction	PC

CELL #12

YARD TYPE: Small Industrial Flat PLACE SIZE: 250k People

STATE	CITY	YARD	R/R
DC	Washington, DC	Ivy City	PC
IL	Chicago	Western Ave.	CMSPP
KY	Louisville	Cane Run	ICG
LA	New Orleans	Harahan	ICG
MO	Kansas City	Mattcon	MATTS
NE	Omaha	Freight House	UP
TX	Austin	Train	MP
TX	Dallas	Cadiz Street	CRIP
TX	Houston	Dollarup	HBT
UT	Salt Lake City	Fourth South	DRGW

TABLE R-2

LIST OF SUBSTITUTE RAILROAD YARDS

	STATE	CITY	YARD	R/R
CELL "1	CA	Bloomington	West Colton	SP
	NJ	Camden	Pavonia	PC
	NY	Mechanicville	Hump	BM
	IL	Silvis	Silvis	CRIP
	MN	St. Paul	New	CMSPP
	MT	Missoula	Train	BN
	MD	Hagerstown	West	WM
CELL "2	VA	Roanoke	Roanoke	NW
	VA	Alexandria	Potomac	RFP
CELL #3	NY	Syracuse	Dewitt	PC
	MI	Detroit	Junction	PC
	TX	Fort Worth	Centennial Hump	TP
	WA	Seattle	Balmer (Interbay)	BN
	CN	New Haven	Cedar Hill	PC
CELL #4	IL	Flora	Train	BO
	BN	Inner Grove	Train	CRIP
	NJ	Port Reading	Port Reading	RDG
	TX	Gainsville	North	ATSF
	TX	Vanderbilt	Train	MP
CELL #5	NY	Binghamton	YD	DH
	WV	Charleston	Bridge Jct.	Joint
	IN	Evansville	Harwood	ICG
	WI	Green Bay	Train	CMSPP
	TX	Amarillo	Train	CRIP
CELL #6	IA	Des Moines	Bell Ave.	CNW
	MD	Baltimore	Bayview	PC
	AL	Mobile	Beauregard	ICG
CELL #7	GA	Brunswick	Brunswick	SCL
	MI	Livonia	Middlebelt	CO
	NJ	Newark	Brills	CNJ
	AZ	Douglas	Douglas	SP
	VA	Hopewell	Train	SCL
CELL #8	TX	Abilene	Abilene	TP
	MI	Kalamazoo	Train	GTW
	PA	Reading	East Reading	PC

TABLE R-2 (Continued)

	STATE	CITY	YARD	R/R
	OH	Akron	Mill Street	EL
	OK	Oklahoma City	Turner	MICT
	MI	Flint	Torrey	GTW
	KY	Louisville	Union Station	LN
CELL #9	FL	West Palm Beach	West Palm Beach	WPBT
	MA	Boston	Yard 8	BM
	TN	Nashville	West Nashville	LN
	NY	New York	Westchester Ave.	PC
	OH	Cleveland	East 26th Street	PC
	OK	Mobile	Train	SLSF
	MN	Sleepy Eye	Train	CNW
CELL #10	KS	Hutchinson	Carey	BN
	ID	Sandpoint	Transfer	UP
	AR	Camden	Train	SSW
	IA	Waterloo	Train	CNW
	SC	Greenville	South	SOU
	TX	Lubbock	Lubbock	FWD
CELL #11	GA	Savannah	Roper Mill	CGA
	VA	Petersburg	Broadway	NW
	WI	Racine	Junction	CMSPP
	CA	Modesto	Train	ATSF
	TX	Fort Worth	Birds	ATSF
	TX	Houston	Bellaire	SP
	WI	Milwaukee	Fowler	CMSPP
CELL #12	WI	Milwaukee	Rock Jct.	CMSPP
	IN	Indianapolis	Caren	PC
	NY	Rochester	Charlotte Dock	BO
	OH	Cincinnati	Fairmont	BO
	WA	Seattle	House	UP

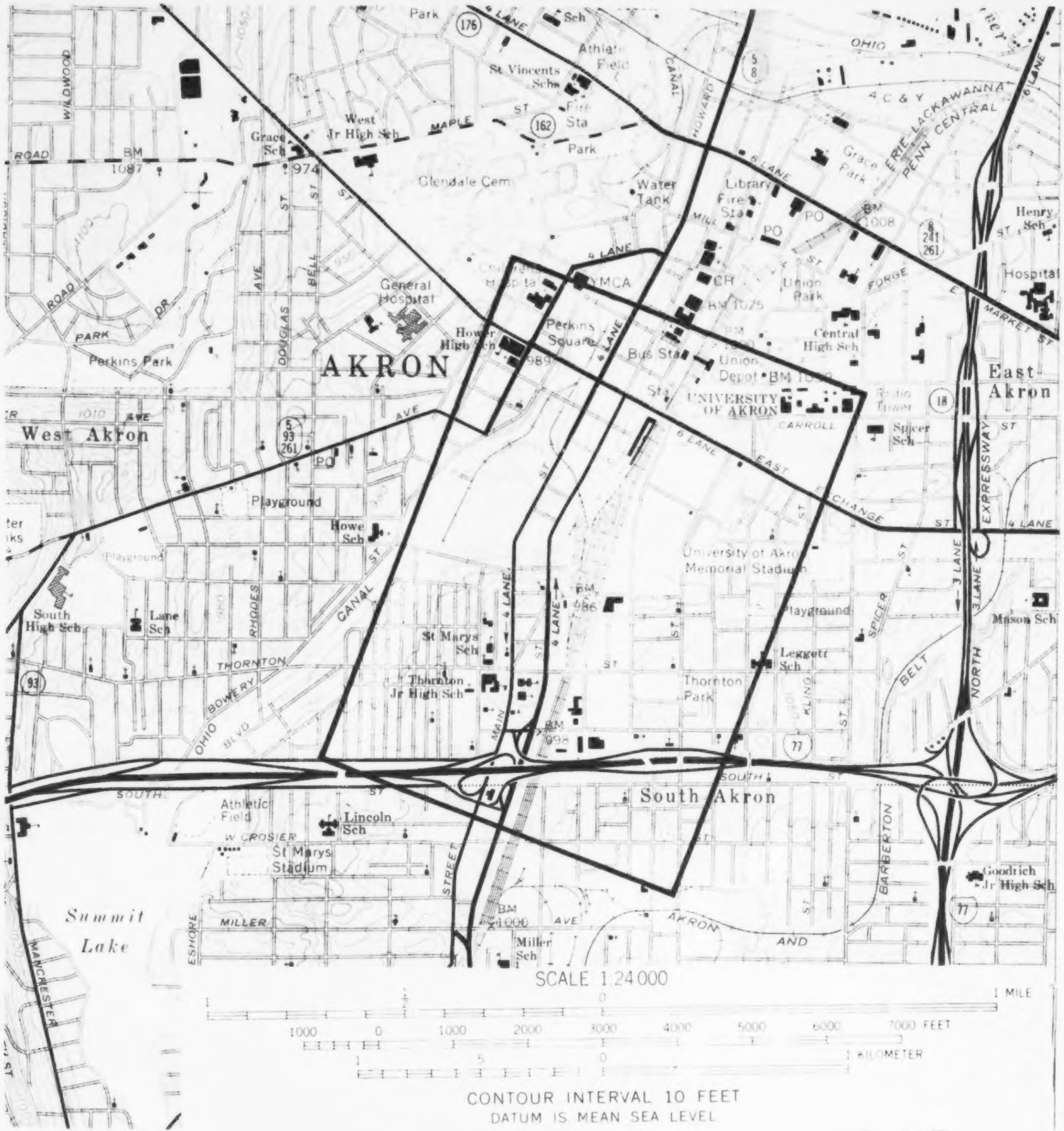

FIGURE R -1. MILL STREET YARD, AKRON, OHIO, WITH STUDY AREA DELINEATED ON U.S.G.S. MAP

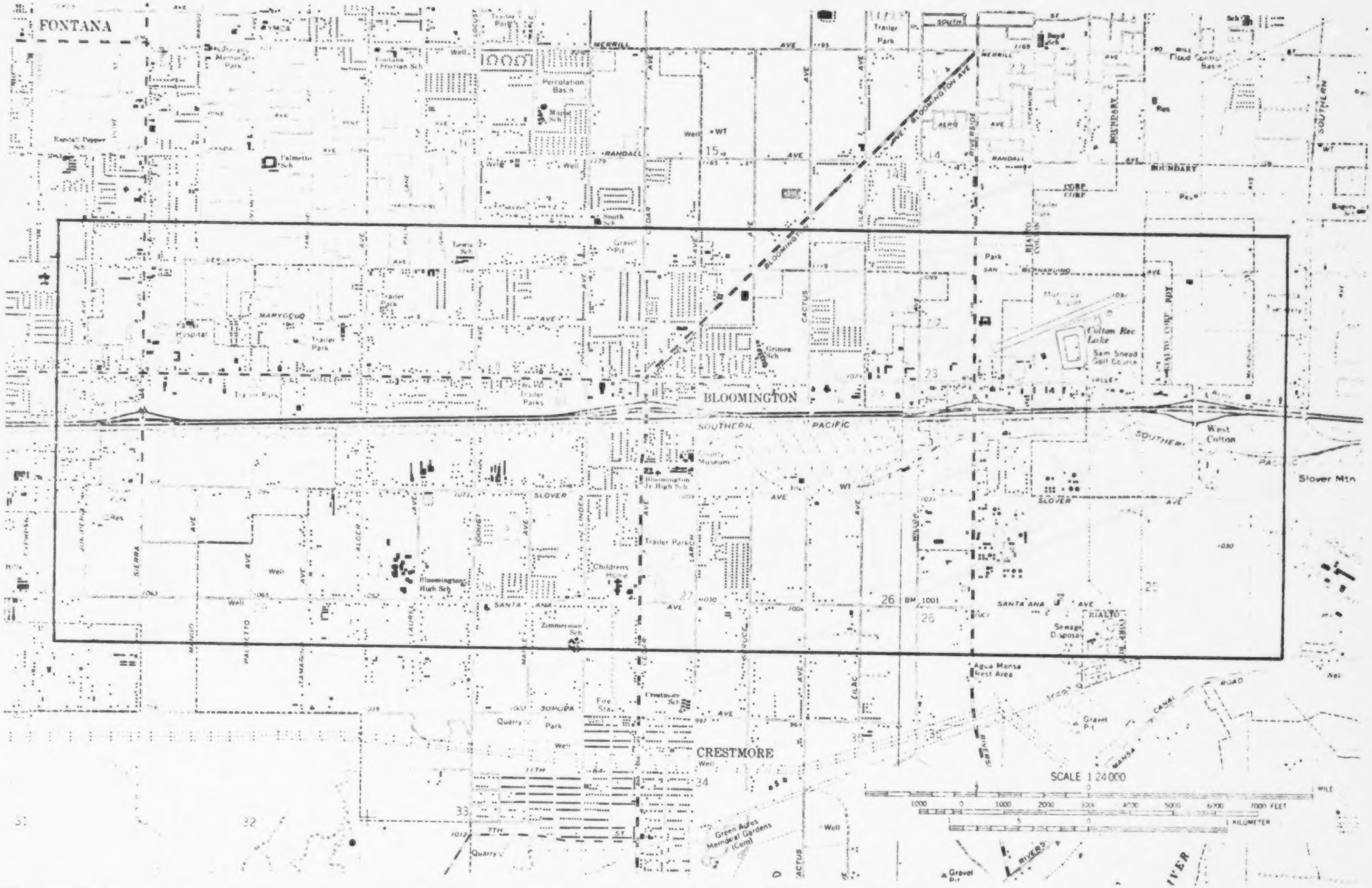

FIGURE R-2. WEST COLTON YARD, BLOOMINGTON, CALIFORNIA, WITH STUDY AREA DELINEATED ON USGS MAP

Reproduced from best available copy.

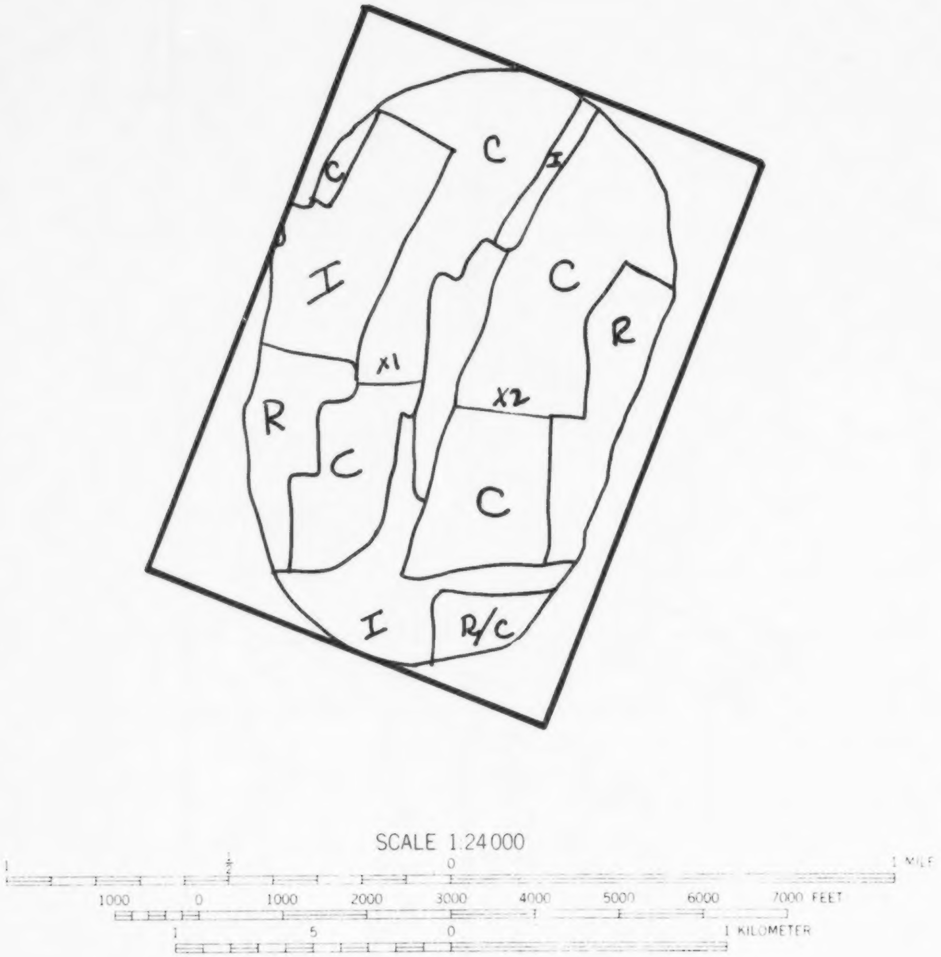

FIGURE R-3. TRACING OVERLAY OF MILL STREET YARDS, AKRON, OHIO

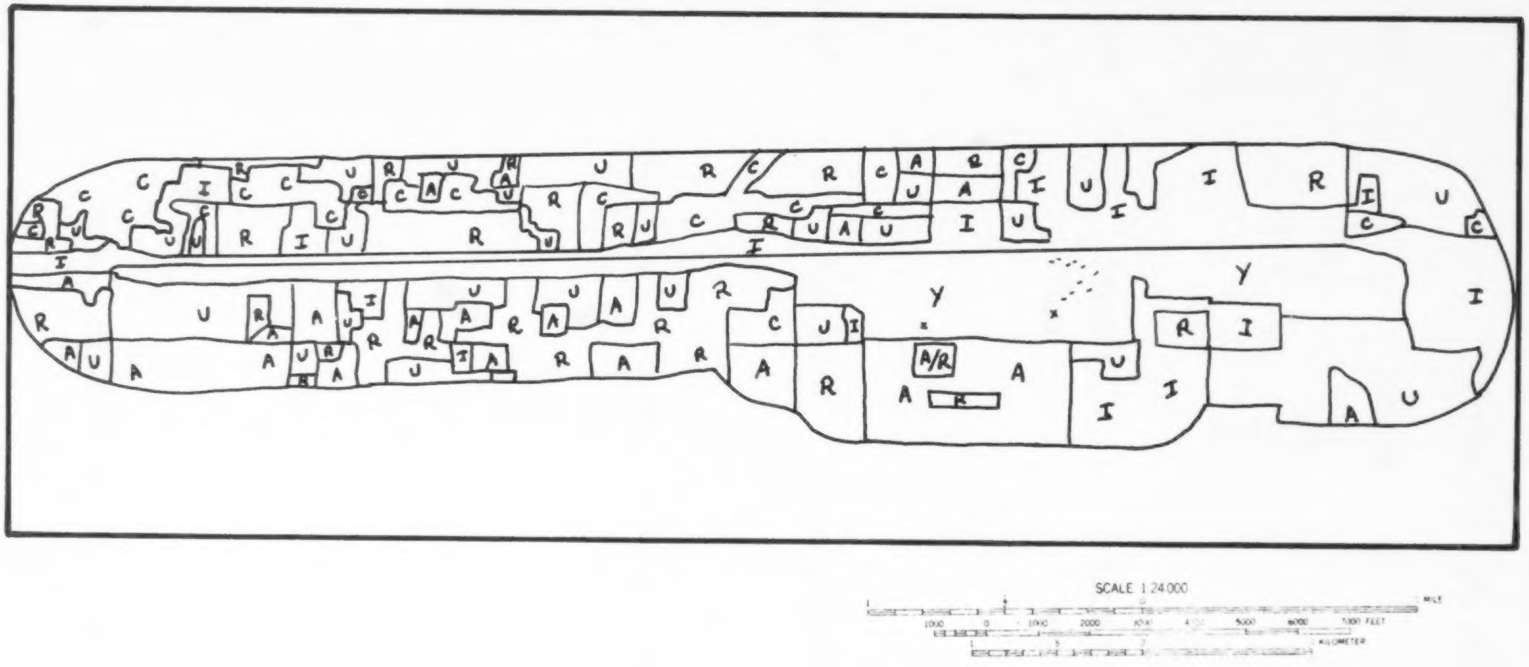

FIGURE R-4. TRACING OVERLAY OF WEST COLTON YARD, BLOOMINGTON, CALIFORNIA

Name Akron, OH., Mill Street Yd., Ind.-Flat

Land Use

	Boundary	2000′
A	0%	
B	90%	
C	10%	
D	0%	
E	0%	

Yard Dimensions

Width B-B	Length	Dist. B-R
680′	3080′	X1 - 770′ (SF) X2 - 1100′ (SF)

Noise Sources

Repair Facilities-B	Master Retarder-B	No. Retarder Stages
None	None	

No. R.E.	Dist. B	Dist. B	No. S.E.	Dist. B.	Dist. B.
3	160′	220′	1	250′	150′

FIGURE R-5. DATA SHEET FOR MILL STREET YARDS, AKRON, OHIO

Name California Bloomington, W. Colton, Class./Ind., Hump

Land Use

	Boundary	2000′
A	9%	
B	0%	
C	69%	
D	6%	
E	16%	

Yard Dimensions

	Width B-B	Length	Dist. B-R
Class.	1680′ (1290′T-T)	5740′	0′ (S.f.) south of east of R.yard
Receiving	360′	12010′	230′(S.f.) north of west end of R.yard
Departure	1390′	5680′	330′(S.f.) south of departure yard
Total Length		25200′	460′(s.f.) north of central portion

Noise Sources

	Repair Facilities-B	Master Retarder-B	No. Retarder Stages
Engine	1190′, 495′	1 - 430′, 530′	
Car	200′, 1450′		3 & 4 stages

No. R.E.	Dist. B	Dist. B
2	130′	200′
3	165′	200′
2	1350′	360′
3	495′	1190′
1	1390′	330′
1	1190′	500′
3	495′	1190′
3	595′	1120′
7	760′	960′
6	820′	700′
2	860′	860′
33	689.39	815.85

No. S.E.	Dist. B.	Dist. B.
3	165′	1550′
3	200′	1515′
2	1455′	265′
1	1390′	330′
1	1550′	155′
3	760′	960′
13	709.62	1106.92

FIGURE R-6. DATA SHEET FOR WEST COLTON YARDS, BLOOMINGTON, CALIFORNIA

APPENDIX S

LAND USE DISTRIBUTION DATA

The percentage distribution of residential commercial, industrial, agricultural and undeveloped land uses was calculated from training overlays (see Figures 6-3 and 6-4) to U.S.G.S. maps. EPIC had delineated yard boundaries as well as land use (per Standard Land Use Coding System) within 2000 ft. from yard boundary.

The percentage land use distribution adjacent to each yard was calculated by using linear distances intercepted along the yard boundary. Then these values were averaged for ten yards in each of the twelve cell-groups by place size and yard type as presented in Table S-1.

The percentage land use distribution within 2000 ft. from each yard boundary was calculated by separately adding the areas of each of the five land uses. Then, these values were averaged for ten yards in each of the twelve cell-groups by place size and yard type as presented in Table S-2.

TABLE S-1

AVERAGE PERCENTAGE LAND USE DISTRIBUTION, ADJACENT TO RAIL YARDS, BY YARD TYPE AND PLACE SIZE

Yard Type	Land Use Classification	Average Percentage Land Use Distribution Place Size (Number of People) <50,000	50,000 to 250,000	>250,000	All Population
Hump Classification	Residential	17.2	9.2	9	11.8
	Commercial	6.7	9.1	4.7	6.8
	Agricultural	3.2	11.2	47.6	20.7
	Industrial	40.0	25.4	8.6	24.7
	Undeveloped	33.0	45.2	30.2	36.1
Flat Classification	Residential	22.2	12.5	9.6	14.8
	Commercial	11.0	6.5	12.8	10.1
	Agricultural	1.8	10.0	61.1	24.3
	Industrial	21.5	44.4	5.7	23.9
	Undeveloped	43.5	26.6	11.0	27.0
Flat Industrial	Residential	13.0	16.0	8.0	12.7
	Commercial	8.0	10.0	21.0	13.0
	Agricultural	8.0	1.0	0	3.0
	Industrial	51.0	68.0	62.0	57.3
	Undeveloped	20.0	5.0	9.0	11.3
Small Flat Industrial	Residential	12.0	16.5	14.0	16.2
	Commercial	13.0	6.2	14.0	11.1
	Agricultural	11.0	3.6	0	6.9
	Industrial	36.0	50.2	61.0	48.1
	Undeveloped	28.0	23.5	10.0	17.8
All Yard Types	Residential	16.1	13.1	10.9	13.6
	Commercial	9.7	9.0	13.1	10.3
	Agricultural	4.0	4.5	15.5	13.5
	Industrial	37.4	47.3	31.6	38.8
	Undeveloped	32.1	25.0	29.1	23.1

TABLE 5-2

AVERAGE PERCENTAGE LAND USE DISTRIBUTION, WITHIN 2000' OF RAIL YARD BOUNDARY BY YARD TYPE AND PLACE SIZE

Yard Type	Land Use Classification	Average Percentage Land Use Distribution Place Size (Number of People) <50,000	50,000 to 250,000	>250,000	All Population
Hump Classification	Residential	30	23	28	27
	Commercial	5	10	7	7
	Agricultural	11	14	13	13
	Industrial	17	19	24	20
	Undeveloped	37	35	27	33
Flat Classification	Residential	42	32	31	35
	Commercial	10	10	13	11
	Agricultural	16	15	6	12
	Industrial	11	18	33	21
	Undeveloped	21	24	17	21
Flat Industrial	Residential	22	49	26	32
	Commercial	5	21	22	16
	Agricultural	12	1	0	4
	Industrial	30	21	37	30
	Undeveloped	30	8	15	18
Small Flat Industrial	Residential	31	28	25	28
	Commercial	14	12	14	14
	Agricultural	17	6	0	8
	Industrial	13	33	46	31
	Undeveloped	25	21	14	20
All Yard Types	Residential	31	33	28	31
	Commercial	9	13	14	12
	Agricultural	14	9	5	9
	Industrial	18	23	35	23
	Undeveloped	28	22	18	23

APPENDIX T

POPULATION DENSITY

In some cases of yards located in scarcely populated areas, the study areas were enlarged to include at least one population centroid. It was indicated by CACI that as long as population within the study area was 500 or more people, the accuracy of the population estimate was at least 10 percent.

The site specific or local average population density is not equal to true residential density since in each study area, the land surface area used to obtain the density value includes the commercial, industrial, agricultural, and undeveloped land. However, the local average density obtained by this procedure reflects more accurately the population impacted than would be the case if the gross average population density for an entire urban area were used. Also, in the health and welfare impact model, the impact is determined according to an integration of density over area so that correct local population is accounted for independent of the micro-distribution of people in the study area.

Since the number of rail yards were given according to 4 yard types and 3 place sizes, there were 12 cells or groups of yard samples to be evaluated. The local average population density within the selected study area at each rail yard was calculated, and the resulting density ranges obtained for the yard types within each cell and for each place size class are shown in Table T-1.

For the 4 cells (or groups of rail yards) in the small place size (less than 50,000 people) class, the local average population densities ranged from 9 to 10,100 people. The population densities around rail yard located in the medium place size and large place size classes, respectively, ranged from 80 to 8130 people/sq.mi. and from 4 to 11,586 people/sq.mi.

Evaluation of the density data indicated low correlation between yard type and population density, and a wide distribution of numbers of yards

TABLE T-1

RANGE OF LOCAL AVERAGE POPULATION DENSITIES AROUND SELECTED RAIL YARDS

	Range of Population Density* (People/Sq.Mi.)		
	Place Size (Population Range):		
Yard Type	1.Less than 50,000	2.50,000 to 250,000	3.Greater than 250,000
Hump Classification	236 to 10,068	90 to 4520	377 to 21,594
Flat Classification	9 to 2,500	127 to 6625	6 to 17,507
Flat Classification	163 to 6,033	1285 to 8135	39 to 19,606
Small Industrial	12 to 8,160	569 to 6,581	658 to 17,049

*Local average

of yards throughout the density range for each cell. Therefore, in each place size, the densities for the 40 sample yards were placed into 7 density classes and the number of yards in each density class was counted. This distribution is shown in Table T-2. A weighted average density was computed for the rail yards in each of the seven density classes for each place size category. The weighted average density for each class was obtained by summing the corresponding study area and population values for the yards in each density range and dividing the total population by the total area:

$$\rho AVG = \sum_i Pi / \sum_i Ai$$

The results are shown in Table T-3. These weighted average density values were used to represent the local average population densities for the rail yards in each density range.

TABLE T-2

DISTRIBUTION OF SAMPLE RAIL YRDS BY POPULATION DENSITY RANGE

Population Density Range (People/Sq.Mi.)	Place Size less than 50,000 people	Place Size 50,000 to 250,000 people	Population Density Range (People/Sq. Mi.)	Place Size Greater than 250,000 people
<500	8	4	<1000	6
500 to 1000	6	5	1000 to 3000	10
1000 to 2000	13	6	3000 to 5000	13
2000 to 3000	7	7	5000 to 7000	2
3000 to 5000	2	10	7000 to 10,000	2
5000 to 7000	2	4	10000 to 15000	3
7000 to 11000	2	3	15000 to 22000	4

TABLE T-3

AVERAGE POPULATION DENSITY FOR EACH DENSITY RANGE CLASS

Population Density Range (People/Sq.Mi.)	Place Size less than 50,000 people	Place Size 50,000 to 250,000 people	Population Density Range (People/Sq. Mi.)	Place Size Greater than 250,000 people
<500	190	230	<1000	420
500 to 1000	780	690	1000 to 3000	1680
1000 to 2000	1380	1470	3000 to 5000	3880
2000 to 3000	2120	2390	5000 to 7000	5750
3000 to 5000	4070	4050	7000 to 10,000	8540
5000 to 7000	5810	5920	10000 to 15000	11700
7000 to 11000	9680	7680	15000 to 22000	18540

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                                     DEMOGRAPHIC PROFILE REPORT          PAGE  1

MILL ST. YARD
AKRON, OHIO                          * * * * * * * * * * * * * * * * * * * * * * *
                                     *                          LATEST    CHANGE *
              DEG MIN SEC            *                                    FROM 0 *
LATITUDE       41   7  30            * 1977 POPULATION            3691     -8.3  *
LONGITUDE      81  30   0            * 1977 HOUSEHOLDS            1420     -1.6  *
                                     * 1977 PER CAP INCOME     $ 3895    $ 10.4  *
 4 POINT POLYGON                     *                                           *
                                     *    ANNUAL COMPOUND GROWTH  -3.0%          *
WEIGHTING PCT   100%                 * * * * * * * * * * * * * * * * * * * * * * *

                                      1970 CENSUS DATA

POPULATION                  AGE AND SEX
TOTAL       4584  100.0%                   MALE             FEMALE         TOAL
WHITE       3328   72.6%    0-5        227  10.0%        234  10.1%        101%
NEGRO       1253   27.3%    6-13       320  14.1%        320  13.8%        140%
OTHER          3    0.1%    14-17      203   9.0%        183   7.9%         84%
                            18-20      201   8.9%        177   7.6%         82%
SPAN          13    0.3%    21-29      388  17.1%        320  13.8%        134%
                            30-39      162   7.1%        207   8.9%         80%
                            40-49      231  10.2%        196   8.5%         53%
FAMILY INCOME (000)         50-64      273  12.0%        371  16.0%        140%
$0-5         334   32.0%    65 +       262  11.6%        311  13.4%        125%
$5-7         148   14.2%    TOTAL     2267              2319
$7-10        259   24.8%    MEDIAN(AGE)     25.2             27.9          264
$10-15       225   21.6%
$15-25        70    6.7%  HOME VALUE (000)          OCCUPATION
$25-50         4    0.4%  $0-10        198  44.9%   MGR/PROF       209  1.9%
$50 +          4    0.4%  $10-15       208  47.2%   SALES           56   .7%
TOTAL       1044          $15-20        34   7.7%   CLERICAL       250  1.6%
                          $20-25         0   0.0%   CRAFT          199  1.2%
AVERAGE  $ 8082           $25-35         1   0.2%   OPERATIVE      404  2.8%
MEDIAN   $ 7663           $35-50         0   0.0%   LABORER         85   .6%
                          $50 +          0   0.0%   FARM             1   .1%
                           TOTAL       441          SERVICE        275  1.3%
                                                    PRIVATE         27   .8%
RENT
$0-100       788   80.9%  AVERAGE  $10724
$100-150     162   16.6%  MEDIAN   $10529
$150-200      19    2.0%  % OWNER    31.2           EDUCATION  ADULTS 25
$200-250       4    0.4%                            0-8            819  3.4%
$250 +         1    0.1%                            9-11           653  3.0%
TOTAL        974                                    12             627  2.9%
                          AUTOMOBILES               13-15           75   .2%
                          NONE         [illegible]  16 +            76   .4%
AVERAGE  $ [illegible]    ONE          [illegible]
MEDIAN   $ [illegible]    TWO          [illegible]
% RENTER   68.8           THREE+       [illegible]
                                                    HOUSEHOLD PARAMETER
                                                    [illegible]
UNITS IN STRUCTURE        HOUSEHOLDS WITH:          [illegible]
[illegible]                                         [illegible]
                                                    [illegible]
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FIGURE B-1. DEMOGRAPHIC PROFILE REPORT OF MILL STREET YARDS, AKRON, OHIO

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                                      DEMOGRAPHIC PROFILE REPORT          PAGE  1
W. COLTON YARD
BLOOMINGTON, CALIF.                     * * * * * * * * * * * * * * * * * * * * * * *
                                        *                                           *
          DEG MIN SEC                   *                      LATEST     CHANGE   *
LATITUDE   34   7  30                   *                                 FROM 70  *
LONGITUDE 117  22  30                   * 1977 POPULATION       8964         317   *
                                        * 1977 HOUSEHOLDS       2821         331   *
 4 POINT POLYGON                        * 1977 PER CAP INCOME $ 4541      $ 2163   *
                                        *                                           *
WEIGHTING PCT   100%                    *   ANNUAL COMPOUND GROWTH    0.5%          *
                                        * * * * * * * * * * * * * * * * * * * * * * *

                                     1970 CENSUS DATA

POPULATION                  AGE AND SEX
TOTAL      8647   100.0%                     MALE              FEMALE          TOTAL
WHITE      8513    98.5%    0-5         493   11.5%         498   11.4%        11.5%
NEGRO        27     0.3%    6-13        880   20.5%         808   18.6%        19.5%
OTHER       107     1.2%    14-17       432   10.1%         371    8.5%         9.3%
                            18-20       182    4.2%         207    4.8%         4.5%
SPAN       1318    15.2%    21-29       476   11.1%         572   13.1%        12.1%
                            30-39       494   11.5%         482   11.1%        11.3%
                            40-49       497   11.6%         512   11.8%        11.7%
FAMILY INCOME (000)         50-64       485   11.3%         499   11.5%        11.4%
$0-5        399    18.7%    65 +        357    8.3%         403    9.3%         8.8%
$5-7        264    12.4%    TOTAL    4296                 4352
$7-10       535    25.1%    MEDIAN(AGE)     24.0                25.6         24.9
$10-15      684    32.1%
$15-25      225    10.5%  HOME VALUE (000)          OCCUPATION
$25-50       27     1.3%  $0-10       214   14.0%   MGR/PROF       362   13.8%
$50 +         0     0.0%  $10-15      634   41.5%   SALES          181    6.9%
TOTAL      2134           $15-20      420   27.5%   CLERICAL       392   15.0%
                          $20-25      169   11.1%   CRAFT          582   22.2%
AVERAGE  $ 9410           $25-35       70    4.6%   OPERTIVS       582   22.2%
MEDIAN   $ 9265           $35-50       14    0.9%   LABORER        151    5.8%
                          $50 +         7    0.5%   FARM            52    2.0%
                           TOTAL     1528           SERVICE        301   11.5%
RENT                                                PRIVATE         15    0.6%
$0-100      449   67.3%   AVERAGE $15443
$100-150    171   25.6%   MEDIAN  $14338
$150-200     46    6.9%   % OWNER   69.6            EDUCATION  ADULTS > 25
$200-250      1    0.1%                             0-8           1151   26.9%
$250 +        0    0.0%                             9-11          1175   27.4%
TOTAL       667           AUTOMOBILES               12            1378   32.2%
                          NONE        166    6.7%   13-15          438   10.2%
AVERAGE   $  88           ONE        1130   45.7%   16 +           142    3.3%
MEDIAN    $  76           TWO         941   38.0%
% RENTER   30.4           THREE+      237    9.6%
                                                    HOUSEHOLD PARAMETERS
                                                    FAM POP       7996   92.5%
UNITS IN STRUCTURE        HOUSEHOLDS WITH:          INDIVIDS       449    5.2%
1          2113   85.1%  TV          2359   95.7%   GRP QTRS       202    2.3%
2            22    0.9%  WASHER      1732   69.8%   TOT POP       8647
3-4          29    1.2%  DRYER        811   32.6%
5-9          18    0.7%  DISHWSH      329   13.2%  NO OF HHLDS      2480
10-49        82    3.3%  AIRCOND     1178   47.5%  NO OF FAMLS      2127
50 +          1    0.0%  FREEZER      602   24.2%  AVG HH SIZE       3.4
MOBILE      206    8.3%  2 HOMES       37    1.5%  AVG FAM SIZE      3.8

                                                                        CACI,INC
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FIGURE D-2.   DEMOGRAPHIC PROFILE REPORT OF WEST COLTON YARD, BLOOMINGTON, CALIFORNIA

APPENDIX U

SOURCE ACTIVITY AND NOISE LEVELS

1. Source Activity Levels

A significant portion of the yard activity data used to provide input for the rail yard health/welfare impact model was based on information presented in a railroad yard survey conducted for DOT in 1976[5]. In this study, yard activity was presented according to yard type, function and level of activity for hump and flat rail yards. These data have been extracted and presented in Tables U-1, U-2, U-3, and U-4 The activity data were used to develop the general noise generation and propagation equations for each source identified. Stationary sources such as groups of retarders were modeled as a single virtual source placed at the geometric center of the grouping. However, since the EPIC survey of 120 rail yards indicated considerable variation in the geometric configuration of the 4,169 rail yards, the exact location for each noise source relative to its corresponding yard boundary cannot be determined. However, the rail yard survey did result in the identification of representative rail yard dimensions and source groupings.

Hump yard complexes are typically composed of yard areas with three separate functions: receiving, classification, and departure.In general, specific activities and functions are performed in each component yard and thus, the different yard noise sources are located by function in the component yards. These noise source groupings and their distribution within each of the component yards are presented in Table U-5.

There is a high degree of uncertainty concerning the location of individual noise sources such as idling locomotives, refrigeration cars, and load test areas within the rail yards. Refrigerator cars and idling locomotives could possibly be found in all yard areas. Load test facilities are usually located between or to one side of the yard areas.

Classification flat yards also have areas similar to hump yards which are differentiated by the specific function performed. Except for

TABLE U-1

ACTIVITY DESCRIPTORS AND TRAFFIC PARAMETERS FOR HUMP RAILYARDS

Yard Activity Descriptors	Yard Activity Level: Low	Medium	High
Inbound Road-Haul Trains Per Day	8	14	27
Outbound Road-Haul Trains Per Day	8	14	25
Local Trains Dispatched Per Day	2	3	5
Makeup Train Operations* Per Day	32	84	150
Number of Classification Tracks	26	43	57
Number of Receiving Tracks	11	11	13
Number of Departure Tracks	9	12	14
Capacity of Classification Yard (Cars)	1447	1519	2443
Capacity of Receiving Yard (Cars)	977	1111	1545
Capacity of Departure Yard (Cars)	862	969	1594
No. of Cars Per Classification Track*	56	35	43
No. of Cars Per Receiving Track*	89	101	119
No. of Cars Per Departure Track*	96	81	114
Number of Cars Classified Per Day	689	1468	2386
Average Outbound Road-Haul Cars Per Train*	79	75	92
Average Local Cars Per Train	43	83	63
Hump Engine Work Shifts Per Day	3	5	6
Makeup Engine Work Shifts Per Day	3	6	11
Local Makeup Train Operations Per Day*	2	18	20
Industrial and Roustabout Engine Work-Shifts Per Day	4	3	14

* Computed From Yard Activity Data.[5]

TABLE U-2

ACTIVITY DESCRIPTORS AND TRAFFIC PARAMETERS FOR FLAT CLASSIFICATION AND CLASSIFICATION/INDUSTRIAL RAILYARDS

Yard Activity Descriptors	Yard Activity Level: Low	Medium	High
Inbound Road-Haul Trains Per Day	3	6	10
Outbound Road-Haul Trains Per Day	3	7	11
Local Trains Dispatched Per Day	2	3	2
Makeup Train Operations* Per Day	12	28	44
Number of Classification Tracks	14	20	25
Standing Capacity of Classification Yard	653	983	1185
Number of Cars Classification Per Day	288	711	1344
Switch Engine Work-Shifts Per Day	4	7	10
Maximum No. of Cars Per Classification Track*	47	49	47
Average Outbound Road-Haul Train Cars Per Day*	73	68	86
Local Train Makeup Operations Per Day*	2	3	8
Industrial and Roustabout Work-Shifts Per Day	2	4	6

* Computed From Yard Activity Data.[5]

TABLE U-3

TRAFFIC PARAMETERS FOR FLAT INDUSTRIAL YARDS

Yard Activity Descriptors	Yard Activity Level
Inbound Road-Haul Trains Per Day	1
Outbound Road-Haul Trains Per Day	1
Local Trains Dispatched Per Day	1
Cars Switched Per Day	140
Switch Engine Work-Shifts Per Day	3

TABLE U-4

TRAFFIC PARAMETERS FOR SMALL INDUSTRIAL FLAT YARDS

Yard Activity Descriptors	Yard Activity Level
Inbound Local Trains Per Day	1
Outbound Local Trains Per Day	1
Cars Switched Per Day	30
Switch Engine Work-Shifts Per Day	1

retarders, which are not usually found in flat yards, the distribution of source groupings is similar to that shown for hump yards in Table U-5. However, the other flat yards do not perform all of the functions performed in the classification yards and the noise source types and source groupings will be distributed differently. Discussion with rail industry personnel indicated that, in general, that switch engines operate at each end of the yard, and the other sources are located inside the main yard area. The noise source groupings for industrial and small industrial flat yards are shown in Table U-6.

Figure U-1 presents a generalized schematic for each of the above yard types and identifies the relative location of noise sources and source groups within each yard complex.

2. Source Noise Levels

A noise generation equation, or model, has been developed for each identified yard noise source. The yard noise sources are categorized as either moving or stationary, and are grouped depending on the source type and relative location within the rail yard boundaries. The noise generation equations are developed in terms of L_{dn} for all sources.

The L_{dn} value for each yard source is computed using an empirical data base on rail yard source noise levels obtained from equipment and facility noise surveys and measurement studies, and from the yard activity data study.[6,12] A discussion of the data used in estimating of the noise generated by each rail yard source is presented below.

For yard activities or operations which are performed on a 24-hour per day basis, the number of occurrences or level of yard activity was indicated by rail industry consultants to be distributed uniformly during the daytime and nighttime periods.

TABLE U-5

HUMP YARD NOISE SOURCE GROUPINGS AND DISTRIBUTION BY COMPONENT YARD TYPE*

Receiving Yard		Classification Yard		Departure Yard	
					Makeup Switchers
	Hump Switchers		Retarders (Master and (Group)		
Source Group (a)		Source Group (b)		Source Group (d)	Industrial Switchers
	Inbound Trains		Idling Locomotives Load Tests		Outbound Trains
		Source Group (c)	Inert Retarders Refrigeration Cars Car Impacts		

*Except for retarders, source groupings and distribution are similar for classification flat yards.

TABLE U-6

INDUSTRIAL AND SMALL INDUSTRIAL FLAT YARD NOISE SOURCE GROUPINGS

Industrial		Small Industrial	
Source Group	Noise Source	Source Group	Noise Source
(a)	Inbound Trains Outboard Trains Switch Engines	(a)	Inbound Trains Outbound Trains Switch Engine
(b)	Car Impacts	(b)	Car Impacts

Hump Yard Noise Sources

1. Inbound/Outbound Road-Haul and Local Train Operations

Based on average train lengths and power requirements, it was assumed that the local and road-haul trains entering and leaving the yard complex are powered by one and three engines, respectively. Train operations were modeled as moving point sources and were assumed to take place within the receiving and departure yard components at a speed of approximately 5 MPH. The number of local and outbound road-haul train operations were combined and treated as a single source type. The number of train operations for each the hump yard activity categories is shown in Table U-1. The train arrivals and departures were uniformly distributed over the daytime and nighttime periods in accordance with the opinion regarding uniform distribution of rail operations by rail industry personnel (see Figures 3-2 and 3-3 for hump yard arrangements). Adjustments were made to the L_{dn} values to account for short periods of high-throttle operation and multiple engine configurations.

2. Hump Engine Switcher Operations

Hump engine operations were modeled as moving point sources which operate in the receiving yard component of the hump yard complex at a speed of approximately 4 MPH. In determining the number of engine pass-bys it was assumed that the average cut of cars to be humped contained 50 cars, since that is the practical limit indicated for a single switch engine. The number of pass-bys per hump engine "trick" (work-shift) is computed by dividing the average number of cars classified per hump engine trick by 50 and multiplying by two. The factor of two accounts for the number of passes required by each hump operation, one to get into position to push the cut of cars and another to perform the push.

As an example, the computation of the number of hump engine pass-bys for the low activity category hump yard will be presented. Table U-1 shows that on a daily basis, there are 689 cars classified by three hump engine tricks. It is assumed that the yard operates 24-hours per day with two tricks during the daytime period and one during the nighttime period, giving an average number of cars classified per hump engine trick of 230. The number of pass-bys per hump engine per shift is therefore equal to nine (2 x 230/50). For the medium and high traffic activity hump yards the number of pass-bys per engine trick is approximately 20 to 32, respectively.

3. Retarders - Master, Group, Intermediate and Track

The master, group, intermediate and track retarders were modeled as a grouped point source located at the geometric center of the retarders. The L_{dn} resulting from cars passing through the retarders is determined from the number of cars classified per day, number of retarders passed by each car and the percentage of cars which cause retarder noise events. Examination of the available data indicated that on the average each car classified passes two retarders, and that retarder squeal occurs approximately 50 percent of the time. Using the number of cars classified per day for the low, medium and high traffic activity hump yards as shown in Table U-1, the number of retarder noise events per day is 700, 1500, and 2400, respectively.

4. Inert Retarders

Inert retarders were also modeled as a grouped point source located at the geometric center of the retarders. In the absence of any data, it was assumed that each car leaving the classification yard passes a retarder and that approximately 85 percent produce a noise event. It was also assumed that the total number of cars passing the retarders is equal to the number of cars classified per day.

5. Car Impacts

Car impacts were modeled as stationary point sources located in the classification yard component of the hump yard complex. It was assumed that the total number of car impacts is equal to the number of cars classified per day (see Table U-1).

6. Makeup, Industrial and Other Switch Engine Operations

Makeup, industrial and other switch engine operations were modeled as moving point sources which operate in the departure yard component of the hump yard complex at a speed of approximately 4 MPH. It was assumed that the total number of cars leaving the classification yard component per day (assumed equal to the number classified per day) is removed in such a way so that an equal number of cars is handled by each switch engine work shift. Therefore, the number of cars handled per work shift is equal to the total number of cars classified divided by the total number of work shifts. Assuming that 10 cars are handled per switch engine operation, the number of pass-bys per work shift was computed by dividing the number of cars handled per work shift by 10 and, assuming round trips are performed, multiplying the result by 2. The total number of pass-bys per day was determined by multiplying the number of pass-bys per work shift by the total number of work shifts.

7. Idling Locomotives and Refrigeration Cars

Both idling locomotives and refrigeration cars were modeled as grouped point sources located in the classification yard component. However, the baseline L_{dn} was developed from a truncated line source model which transformed the line of point sources into a grouped or virtual point source. This was considered appropriate since the sources may be grouped in a square or rectangular pattern. The resulting expression which accounts for the number of sources, and rows, and extra air and ground absorption is given by:

$$L_{dn} = L_{eq_H} + 10 \log \frac{1}{24}(NH_d + 10NH_n) + 8 \log(1.33N_1) - 20 \log\left(\frac{D}{Do}\right) + 10 \log(NR) - K(D)$$

where L_{dn} = baseline day-night average noise level, dB

L_{eq_H} = average noise level (per 1-hour period) of a single locomotive or refrigeration car at a distance of 100 feet, dB

N_1 = number of locomotives or refrigeration cars per row

NH_d and NH_n = number of hours of operation during daytime (d) and nighttime (n)

NR = number of rows of locomotives or refrigeration cars

D_o = 100 feet

D = distance from source to yard boundary

K(D) = air and ground absorption

Based on the number of locomotives and refrigeration cars in the rail company inventory, the number of rows and the number of idling locomotives and refrigeration cars per row assumed for each hump yard traffic category ar shown below:[5,8]

TRAFFIC RATE CATEGORY	IDLING LOCOMOTIVES NUMBER OF ROWS	NUMBER PER ROW	REFRIGERATION CARS NUMBER OF ROWS	NUMBER PER ROW
Low	2	2	2	5
Medium	3	2	4	5
High	3	2	6	5

8. Locomotive Engine Load Tests

Locomotive load tests were modeled as stationary point sources located in the classification yard component. It was assumed that load tests are conductd at high activity category hump yards only. Also, it was assumed that one 6-hour test was performed per day with 4 and 2 hours of operation occurring during the daytime and nighttime periods, respectively.

Flat Classification Yard Noise Sources

1. Inbound/Outbound Road-Haul and Local Train Operations

As previously discussed, it was assumed that local and road-haul trains entering and leaving the classification yard complex are powered by one and three engines, respectively. Train operations were modeled as moving point sources and were assumed to take place in the receiving and departure yard components at a speed of approximately 5 MPH. The number of local and outbound road-haul train operations were combined and treated as a single source type. The number of train operations for the three flat classification yard activity categories is shown in Table U-2. It was assumed that all train operations are uniformly distributed over the daytime and nighttime periods.

2. Switch-Engines Operations: Classification, Industrial, and Roustabout

Switch engine operations were modeled as moving point sources which operate in the receiving and departure yard components at a speed of approximately 4 MPH. The rationale used in determining the operational parameters is the same as that discussed for the makeup and industrial switch engine operations in hump yards. However, for flat classification yard operations, it was assumed that only 5 cars are handled per switch engine operation.

To allow for variations in the distribution of switch engine operations for future impact assessment, switch engine operations have been modeled as two separate yard sources, one at each end of the yard complex. It is assumed that all switch engine operations are equally distributed between the two locations and that the yard operates 24-hours per day.

3. Car Impacts

Car impacts were modeled as stationary point sources located in the classification yard component. In the absence of specific data, it is assumed that the total number of car impacts is equal to the number of cars switched or classified per day. (See Table U-2).

4. Idling Locomotives and Refrigeration Cars

Both idling locomotives and refrigeration cars were modeled as grouped point sources located in the classification yard component. The noise generation model and the baseline L_{dn} development procedures have been previously discussed.

The number of rows and the number of idling locomotives and refrigeration cars per row which were assumed for each flat classification yard traffic category are shown below:

TRAFFIC RATE CATEGORY	IDLING LOCOMOTIVES NUMBER OF ROWS	NUMBER OF CARS	REFRIGERATOR CARS NUMBER OF ROWS	NUMBER OF CARS
Low	2	2	2	5
Medium	3	3	4	5
High	3	3	6	5

5. Locomotive Engine Load Tests

Locomotive engine load tests were modeled as stationary point sources located in the classification yard component. As in the hump yard case, it was assumed that testing is performed in high activity category flat yards only and that one 6-hour test is conducted per day with 4 and 2 hours of operation occurring during the daytime and nighttime periods, respectively.

Flat Industrial Yard Noise Sources

1. Inbound/Outbound Road-Haul and Local Train Operations

It was assumed that local and road-haul trains entering the yard complex are powered by one engine, and departing road-haul trains are powered by three engines. Train operations were modeled as moving point sources at a speed of approximately 5 MPH. The number of local and outbound road-haul train operations were combined and treated as a single source type. All sources were assumed to operate within the yard complex. The number of road-haul and local train operations determined for the flat industrial yards is shown in Table U-3. It was assumed that all train arrivals and departures are uniformly distributed over the daytime and nighttime periods.

2. Switch Engine Operations

Switch engine operations were modeled as moving point sources at a speed of approximately 4 MPH. The rationale used in determining the operational parameters is the same as that discussed for the makeup and industrial switch engine operations in hump yards. The number of switch engine tricks per day is shown in Table U-3. It was assumed that the yard operates 24-hours per day and that all switching operations are performed at one end of the yard complex, since this type of flat yard is too small to warrant switching at both ends simultaneously.

3. Car Impacts

Car impacts were modeled as stationary point sources located at the center of the yard complex. It was assumed that the total number of car impacts is equal to the number of cars switched per day (See Table U-3) and that the yard operates 24-hours per day.

Small Industrial Flat Yard Noise Sources

1. Inbound/Outbound Road-Haul Train Operations

It was assumed that road-haul trains entering or leaving the yard complex are powered by one engine. Train operations were modeled as moving point sources at a speed of approximately 5 MPH. All sources were assumed to operate within the yard complex and it was assumed that all train arrivals and departures are uniformly distributed over the daytime and nighttime periods. The number of road-haul train operations for the small industrial yards is shown in Table U-4.

2. Switch Engine Operations

Switch engine operations were modeled as moving point sources at a speed of approximately 4 MPH. The rationale used in determining the operational parameters is the same as that discussed for industrial switch engine operations in hump yards. The number of switch engine tricks per day is shown on Table U-4. It was assumed that the yard operates 24-hours per day and that all switching operations are performed at one end of the yard complex.

3. Car Impacts

Car impacts were modeled as stationary point sources located at the center of the yard complex. It was assumed that the total number of car impacts is equal to the total number of cars switched per day (see Table U-4) and that the yard operates 24-hours per day.

Noise Propagation Attenuation Factors

Previous analyses of noise propagation losses in various types of urban areas have resulted in generalized approximations for the total attenuation with distance including air and ground absorption, and buildings acting as noise barriers. In general, these analyses appear to have been done for road traffic (line) noise sources which characteristically have most of their noise energy distributed in the 100 to 1000 Hz. frequency range. The results for the composite attenuation between 100 and 500 feet were approximately 14 dB, 12 dB, and 8 dB per doubling of distance for urban high rise, urban low rise, and open terrain areas, respectively.

It was considered that these "distance attenuation" relationships were not applicable to the rail yard noise case due to the wider variety of noise sources (point and moving), many of which have considerably different spectral characteristics than traffic noise sources. As discussed earlier in the subsection on rail yard noise sources, retarder squeal, car impacts, and other sources have dominant noise energy in the 1000 to 4000 Hz. range, while idling locomotives and switch engine operations produce dominant noise energy in the low frequency (100 Hz) range. The result is that air and ground absorption factors may be significantly different for the rail yard noise sources than for the road traffic noise.

Therefore, an analysis was conducted to determine air and ground attenuation factors for each type of noise source in the rail yards, and building insertion loss factors for the medium- and low-density land use areas surrounding rail yards. The analysis and results are presented in the following paragraphs. The resulting attenuation factors apply to the rail yard noise sources and locations only, and are not likely to be appropriate for regulatory noise analyses for other products or noise sources.

Divergence Loss

The variation of noise with distance from the source because of divergence loss, i.e., spreading of noise energy over larger and larger areas, for stationary (individual and grouped) sources in the rail yards is a function of 20 $\log_{10}$ (distance ratio) assuming that the sources radiate in the normal hemispherical pattern. Since the determination of L_{dn} values for the stationary sources is based on L_{eq} or SENEL values which are dependent only on noise event durations, the decrease in L_{dn} with distance is also a function of 20 $\log_{10}$ (distance ratio).

In the case of the moving sources, e.g., switch engines, L_{dn} is developed from SENEL per pass-by and the number of pass-by events. At a particular distance from the source the SENEL value is a function of the speed of the source and the maximum noise level (L_{max}) during the pass-by:

$$\mathrm{SENEL}_1 = L_{max_1} + 10 \log \Pi \frac{D_1}{V}$$

where:

D_1 = distance from source to observer (ft.), and

V = source speed (ft./sec.).

Then at any other distance, D_2 -

$$\mathrm{SENEL}_2 = L_{max_1} - 10 \log \left(\frac{{D_2}^2}{D_1} \right) + 10 \, \mathrm{Log} \, \Pi \frac{D_2}{V}$$

However, this reduces to:

$$SENEL_2 = L_{max_1} + 10 \log \Pi \frac{D_1}{V} - 10 \log \frac{D_2}{D_1}, \text{ or}$$

$$SENEL_2 = SENEL_1 - 10 \log \frac{D_2}{D_1}$$

Therefore, the divergence loss applicable to L_{dn} values for moving sources is a function of 10 log (distance ratio) rather than 20 log (distance ratio).

Air and Ground Absorption Factors

The rail yard noise sources have been identified, or simplified, as either moving point sources or stationary (virtual point) sources. The noise level reduction with distance is a function of the type of source, (stationary or moving), and its characteristic noise spectrum. Thus, in addition to the usual divergence or spreading loss, the noise energy is dissipated in the air medium and absorbed along the ground surfaces. The air attenuation and ground absorption are dependent mainly on the predominant frequencies in the noise spectrum and also on the relative humidity and air temperature. For these analyses, it was assumed that the average conditions would be a typical day with an air temperature of 60° F and a relative humidity of 60 to 70 percent. Nominal expressions for air and ground attenuation developed by DOT, FAA, and other sources are:

$$A_{air} = \frac{2fd}{10^6}$$

$$A_{ground} = 10 \log_{10} \left[\frac{fd}{4x10^5}\right], \text{ for } fd > 4x10^5,$$

$$A_{ground} = 0, \text{ for } fd \leq 4x10^5,$$

where:

A = attenuation, dB
f = sound frequency, Hertz, and
d = distance from source, feet.

However, since the noise model must compute L_{dn} values, and since the L_{dn} noise rating scale is based on A-weighted sound levels, it is more convenient to use a combined air and ground attenuation factor representing the attenuation of the A-weighted noise levels with distance. Thus, the rail yard noise source data base was used to obtain an average or typical noise spectrum, in terms of octave band sound levels, for each type of source. In general, the data base provided typical spectral levels at 50 or 100 feet. For each typical source the air and ground attenuation was calculated for 100 to 2000 foot distances using the center frequency of each octave band for the f value in the equations given above. The A-weighted level at each distance was then computed from the correspondingly attenuated octave band noise levels, and the differences between the levels at the selected distances were used to determine the extra attenuation (A_{a+g}) in dB attributable to air and ground absorption. An approximation to the average extra attenuation factor $1/2\left[\frac{A_{a+g}}{1000} + \frac{A_{a+g}}{2000}\right]$, was obtained by inspecting the values for the source at the 1000 and 2000 foot distances.

A review of octave band spectra for the seven major types of rail yard noise sources indicated a wide variation in the predominant noise energy frequencies. Because the level of extra attenuation increases directly with the sound frequency, as indicated by the air and ground attenuation equations shown above, the greatest noise level attenuation will occur for the noise sources whose levels are dominated by high-frequency components. The data base indicated, for example, that the noise source with the highest predominant frequencies were the retarders. The retarder screech, or squeal, sound energy is concentrated in the 2000 to 4000 Hz frequency level. Using the procedure outlined in the preceding discussion, the combined air and ground attenuation for retarder noise was calculated to be 10 dB per 1000 feet. Other noise sources such as car impacts and refrigerator cars produce A-weighted sound energy predominantly in the mid-frequency range (1000 to 2000 Hz), and the combined attenuation factors were determined to be in the 3 to 5 dB per 1000 foot range. Locomotive sources, switch engines and road-haul engines, were generally characterized by low-frequency (<500 Hz) sound energy, and the combined attenuation factors were 1 to 2 dB per 1000 feet. The resulting combined air and ground absorption factors, in terms of dB per foot, are shown for each noise source-type on Table U-7. Based on the attenuation factors presented on Table U-7, average combined absorption coefficients were computed for each of the source groupings shown on Tables U-5 and U-6. A listing of these average attenuation factors is shown on Table U-8.

Table U-7

COMBINED AIR AND GROUND ATTENUATION FACTOR FOR MAJOR RAIL YARD NOISE SOURCES

Noise Source	Combined Air and Ground Attenuation Factor (dB/ft)
Retarders	0.01
Switch Engines	0.001
Car Impacts	0.005
Idling Locomotives	0.0025
Locomotive Load Tests	0.002
Refrigeration Cars	0.0035
Road-Haul Locomotives	0.002

Insertion Loss Due to Buildings

The DOT rail yard survey indicated that the 4000 rail yards were widely distributed relative to the surrounding land use and the size of the cities where they are located. Examination of yard locations and surroundings in different cities from 20 to 30 USGS quadrangle maps indicated that relatively few rail yard complexes were situated in central business districts characterized by tall multi-floor buildings and high-density land use. Thus, from the yard distribution data, it was determined that noise level attenuation factors due to intervening

TABLE U-8

AVERAGE COMBINED AIR AND GROUND ATTENUATION FACTORS FOR RAIL YARD NOISE SOURCE GROUPS

Yard Type	Noise Source Group	Average Combined Air and Ground Attenuation Factor, dB/Ft.
Hump	(a)	0.0015
	(b)	0.005
	(c)	0.0062
	(d)	0.0013
Flat Classification	(a)	0.0015
	(b)	0.0023
	(c)	0.0043
	(d)	0.0015
Industrial and Small Industrial Flat	(a)	0.0017
	(b)	0.005

buildings were necessary for two cases: (1) residential area with single-floor houses, and (2) residential, commercial, or other areas with multi-floor buildings.

Typical insertion loss factors for the first row and additional rows of buildings have been developed by many authors.[13-14] These factors were developed generally for highway traffic noise sources (line sources) and are applicable when the location of the buildings relative to the source is known, or when the conditions are similar to those for which the factors were developed. In the general case of the rail yards and their surrounds, the typical distances from the noise sources to the buildings, or the spacings between the buildings on the receiving land are not known.

Therefore, it was necessary to reexamine the insertion loss data to determine a generalized approximation for insertion loss due to buildings in the non-specific case of the rail yards and their surroundings. The data used to obtain the insertion loss values in FHWA/NCHRP Reports 117 and 144 and in other sources to obtain the insertion loss values were reviewed.[13-14] When the overall conditions, including background noise effects, were taken into consideration the expected total insertion loss for several rows of buildings was in the range 5 dBA for low-density residential areas (single-floor dwellings), and 8 dBA for higher-density areas of multi-floor buildings. Since the distances to the buildings are not known for rail yards noises, average losses of 5 dB per 1000 feet and 8 dB per 1000 feet were used for the lower and higher density areas, respectively.

APPENDIX V

RELATIONSHIP BETWEEN ONE HOUR L_{eq} LIMITS AND DAY-NIGHT NOISE LEVELS AND COMPARISON OF ANNUAL AVERAGE WITH DAILY DAY-NIGHT NOISE LEVELS

PART A: One L_{eq} Versus Day-Night Levels

The day-night sound level measured in the vicinity of a railroad yard will differ from the one-hour equivalent sound level, L_{eq}, by an amount that varies with the number of hours during which activities occur. This fact complicates the selection of compatible L_{eq} and L_{dn} limits, since the difference between these two measures may vary considerably from yard to yard, and even from day-to-day at the same yard.

Table V-1 shows the difference between the L_{dn} and the maximum one-hour L_{eq} in both day and nighttime periods for various time periods during which railyard activities might occur. Thus, if railroad yard activities occur during one daytime hour, the L_{eq} for that hour will be 13.8 dB above the L_{dn} for the day. If yard activities occur during an 8-hour daytime period, the L_{eq} during each hour (or more correctly, the one-hour L_{eq} averaged over all 8 hours) would be 4.8 dB above the L_{dn} for that day.

Consider the situation in which the daytime L_{eq} limit is set at 13.8 dB above the L_{dn} limit, and the nighttime L_{eq} limit is set at 3.8 dB above the L_{dn}. If either of these limits are exceeded, the L_{dn} must also be exceeded. Thus, selection of these limits assures compatibility between L_{eq} and L_{dn} limits. However, for most railroad yards where operations occur during more than one hour of the day, such L_{eq} limits will be very lenient. That is, a one-hour measurement may not show that the standard is exceeded even though the L_{dn} for that day may well be in excesss of the L_{dn} limit.

Selection of L_{eq} limits for daytime and nighttime hours which are less than the 13.8 and 3.8 dB, respectively, provide some risk in that the L_{eq} limits may be exceeded but not the L_{dn} limits. Thus, selection of L_{eq} limits must be based on a tradeoff between the desirability to have low enough L_{eq} limits to permit reasonable enforcement based on an L_{eq} rather than an L_{dn} measurement, and the desirability to limit the 24-hour noise exposure rather than the noise exposure during individual hours.

While the differences shown in Table V-1 represent possible differences that may occur at a yard, Table V-2 shows the differences that were actually measured at 42 different locations in the vicinity of 18 railyards (where rail noise was dominant), representing a total sample of 55 measurement days. The table shows that L_{eq} limits 3.2 dB above the L_{dn} for the daytime L_{eq}, and 0.1 dB above the L_{dn} for the nighttime L_{eq} represent 95 percent confidence limits; that is, if these L_{eq} limits were exceeded, there is a 95 percent probability that the L_{dn} limits would be exceeded as well. It would seem that the optimum selection of L_{eq} limits would be somewhere in the range between these values and the 13.8 dB daytime and 3.8 dB nighttime values discussed above.

Because of the 10 dB nighttime weighting incorporated within the L_{dn} measure, selection of nighttime L_{eq} limits which are 10 dB less than the daytime L_{eq} limits will result in control of the same number of daytime and nighttime hours. Such an approach leads to the selection of 10 dB and 0 dB as the differences between the daytime and nighttime L_{eq} limits, respectively, and the L_{dn}. Thus, for example, an L_{dn} limit of 65 dB would result in selection of a daytime L_{eq} limit of 75 dB and a nighttime L_{eq} limit of 65 dB. These limits would assure that if the nighttime L_{eq} was exceeded, there is 95 percent confidence that the L_{dn} is exceeded, and if the daytime L_{eq} is exceeded, there is nearly 100 percent confidence that the L_{dn} would be exceeded. Only if rail yard operations occur for less than about 2-1/2 hours during either the day or the night would exceeding these limits not also result in the day-night level being exceeded. This clearly is a situation not likely to occur at the great majority of rail yards.

TABLE V-1

MAXIMUM HOUR EQUIVALENT LEVEL/DAY-NIGHT LEVEL DIFFERENCES

Number of hours of Operation/Period	Day L_{eq} $(1)_{max}$ - L_{dn}	Nite L_{eq} $(1)_{max}$ -L_{dn}
1	13.8 dB	3.8 dB
2	10.8	0.8
4	7.8	-2.2
9	4.3	-5.7
15	2.0	

TABLE V-2

MEASURED L_{eq}/L_{dn} DIFFERENCES*

	Day L_{eq} $(1)_{max}$ - L_{dn}	Nite L_{eq} $(1)_{max}$ -L_{dn}
Maximum Difference	4.5 dB	2.8 dB
Average Difference	-1.0	-2.8
Minimum Difference	-9.4	-5.9
Upper Limit of 95% confidence interval	3.2	0.1

* Based on 55 measurement days.

PART B: Annual Average Versus Daily Day-Night Sound Levels

The day-night sound level measured on a particular day in the vicinity of a railroad yard may differ from the annual average day-night sound level at the same location (that is, the energy average of the day-night sound levels measured on each day of a full year), because of both the daily and seasonal variation in operations that may occur at the yard. If a yard were to maintain a constant level of activity, day in and day out throughout a full year, the day-night sound level measured on any day would be equal to the annual average day-night sound level. When yard activities vary, such as when a yard handles a particular commodity with seasonal variation in production, there could be a large numerical difference between the daily and annual values of the day-night sound level.

In order to estimate the size of possible differences, Table V-3 lists adjustment factors for daily, weekly, and monthly variability in level of activity at the rail yard. The table utilizes the concept of a typically "active" day, as a way of categorizing yard operations. The term typically active implies a normal level of activity or operation at the yard. If a yard has five typically active days a week and is then shut down for the remaining few days, Table V-3 indicates that the day adjustment is minus 1.5 dB. If there are five typically active days, and the level of activity on the remaining 2 days is about half the normal level of activity, this would count as a total of six active days per week (five full days plus 2 half days). The day adjustment for this condition would be -.7 dB.

Similarly, the week and month adjustments can be obtained from the table using estimates of the total number of typically active weeks per month and months per year, respectively. The numerical sum of these three adjustments is the year adjustment: Year adjustment = Month adjustment + Week adjustment + Day adjustment. Then the average L_{dn} is related to the L_{dn} measured on a typically active day as follows:

Annual average L_{dn} = Daily L_{dn} (for active day) + Year adjustment.

TABLE V-3

ADJUSTMENTS FOR VARIABILITY IN OPERATIONS

No. of Active Months/Year	Month Adjt.	No. of Active Weeks/Month	Week Adjt.	No. of Active Days/Week	Day Adjt.
12	0	4-1/3	0	7	0
11	-0.4	4	-0.3	6	-0.7
10	-0.8	3	-1.6	5	-1.5
9	-1.3	2	-3.4	4	-2.4
8	-1.8	1	-6.4	3	-3.7
7	-2.3			2	-5.4
6	-3.0			1	-8.5
5	-3.8				
4	-4.8				
3	-6.0				
2	-7.8				
1	-10.8				

For example, if a yard is active five days per week every week of the month, ten months per year, the year adjustment is (-1.5)+(-.8) or -2.3. As mentioned above, a yard that is active almost all of the year has a year adjustment of 0. In contrast, the yard with a highly seasonal variability might be completely active seven days a week every week of the month but for only a season (three months). In this example, the year adjustment would be -.6.